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HEPATOSPLENOGRAPHY WITH STABILIZED THORIUM DIOXIDE SOL

A FOLLOW-UP STUDY OF 200 PATIENTS EXAMINED OVER A PERIOD OF FIVE YEARS[1]

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SINCE 1928, when Oka (1 and 2), in Tokio, and soon thereafter Radt (3 and 4), in Berlin, began work to develop a method for demonstrating the morbid anatomy of the liver and spleen on x-ray plates by means of thorium preparations injected into the blood stream, several groups of investigators have had a moderately large experience with this procedure. However, those who have used this method of diagnosis have been relatively few due to the facts that thorium dioxide, the substance adopted, possesses some radioactivity and is eliminated from the body with extreme slowness. In 1932, the Council on Pharmacy and Chemistry of the American Medical Association (5) reported unfavorably on the intravenous use of thorium dioxide and urged great caution in its use in man. One of the points stressed in this report was that there is a possibility that the thorium dioxide in the tissues might be converted as time went on, in part at least, to some more radio-active substance, such as mesothorium, and that radium poisoning possibly would result.

The purpose of this report is to review the experience of our use with this method of diagnosis, which has covered a period of nearly five years and which has involved considerably more than 200 patients. The preparation we have used in all our cases has been a stabilized colloidal solution of thorium dioxide containing approximately 22 per cent of metal by volume.[3] This substance, when injected into the blood stream, is rapidly removed and engulfed by the reticulo-endothelial cells throughout the body. These cells, being most numerous in the liver and spleen, allow these organs to be demonstrated on x-ray films, because thorium, a metal of high atomic weight, is radiopaque. The average dose employed by us has been 75 c.c., being given usually in divided doses of 25 c.c. on successive days. This amount of the solution contains a quantity of thorium dioxide equivalent in alpha-ray activity to from 1.5 to 3.0 micrograms of radium. The beta-ray and gamma-ray activity is probably insignificant.

Even after a period of five years x-ray films demonstrate that there is still a large amount of the metal present in the body, but there is also definite evidence of some

[1] Read before the Section on Practice of Medicine at the American Medical Association Session, Kansas City, Mo., May 13, 1936.

[2] Dr. Otell died July 27, 1936.

[3] The preparation employed was thorotrast, manufactured by the Heyden Chemical Corporation of New York.

mobilization of it from the original reticuloendothelial cells in which it was deposited.

Immediate reactions due to the injection of the solution in the amount used have been extremely few and on the whole extremely mild. In the last three years we have not noted any immediate reactions that were apparent to ordinary observation. Some patients have received as much as 100 c.c., and one was given this entire amount within one hour without an appreciable reaction. A number of others have had 50 c.c. injected at one sitting without reactions.

Solution of thorium dioxide is also of value in other fields of roentgenology. It is the best medium for arteriography, and it is satisfactory for ventriculography and retrograde pyelography. Our previous reports (6, 7, and 8) and those of others who have had considerable experience with hepatosplenography, have demonstrated its usefulness in the diagnosis of intra-abdominal disease. In the report of our clinical experience with our first 80 patients (7), we concluded with the statement that "greater experience with it will reveal its true value, its finer points, and its limitations." We feel that we have progressed considerably in the direction of knowing these facts.

TECHNIC OF HEPATOSPLENOGRAPHY

Until recently we have employed an average of 75 c.c. of the stabilized solution of thorium dioxide in adults of average size, and have reduced the total dosage in children roughly in proportion to the weight. We have experimented with smaller doses to determine the smallest amount which would be satisfactory for good detail of the structure of the liver and spleen in the films. We have come to the conclusion that perhaps a little less than the total dosage previously employed may be satisfactory, and we are now using 0.5 c.c. for each pound of body weight. One-third of the total dosage is usually injected intravenously on each of three successive days, and on the fourth day or any time thereafter the films are made.[4] No particular preparation of the patient is necessary except that it is advisable to have the intestinal tract as free of gas as possible when the x-ray exposures are made.

Films are taken with the patient in the prone position on the Potter-Bucky diaphragm, the tube being centered over the ensiform cartilage. The following technic is quite satisfactory: 67 kilovolts peak at 30 milliamperes for 6 seconds at 30 inches distance. Eastman or Du Pont films are satisfactory. No compression is made. A more comprehensive idea of the structural characteristics of the liver and spleen is obtained by making several exposures within a range of 10 kilovolts of this dosage. In larger individuals the film should be placed transversely in order to include the entire liver and spleen. Dilution of the solution is unnecessary, and the preparation may be injected at about room temperature. The solution is opalescent, odorless, and has the consistency of heavy oil.

APPEARANCE AND SIZE OF THE NORMAL LIVER AND SPLEEN

In good films made within a year or two after the injection of the solution, the liver casts a relatively homogeneous shadow of approximately the same density as the spine (Fig. 1). Occasionally blood vessels in the liver are seen as dark branching lines. The spleen normally has a density slightly less than that of the liver and about the same as that of the ribs. The splenic shadow is usually homogeneous but occasionally is uniformly mottled. So far as determination of the size of the liver and spleen is concerned, this can be done only roughly, especially in comparative progress films. We have noted considerable variation in the size of the liver shadow on films taken within a short period of each other.

[4] If haste is necessary, the entire amount of thorotrast may be injected at one time and the films made as soon as one hour afterward. Experiments made by us show that the liver and spleen contain thorotrast as early as 15 minutes after injection. At the end of two hours good detail is present, and after four hours no further improvement in detail is apparent. If the amount of thorotrast injected does not allow good detail, an additional 15 to 25 c. c. is injected.

Fig. 1.

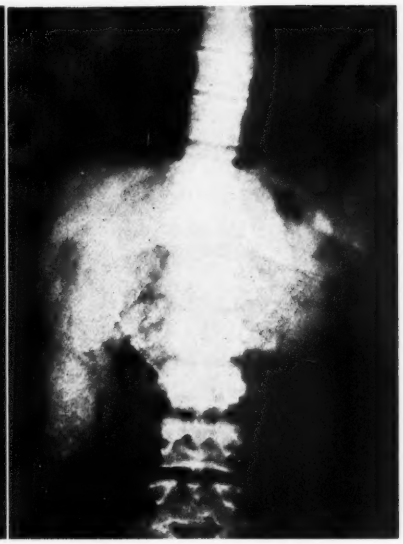

Fig. 2.

Fig. 1. Normal hepatosplenogram.
Fig. 2. Cirrhosis of the liver. Film made more than two years after injection of stabilized thorium dioxide sol. The liver is granular; the left lobe is enlarged. Opaque masses seen on each side of the spine are lymph nodes containing mobilized thorium dioxide (Case 6).

Apparently there is no absolutely normal size that may be used as a standard, although our average normal "length" of the liver shadow, as measured from the highest point of the upper border to the lowest point of the tip of the right lobe, varied between 18 and 22 cm., and the average "oblique measurement," from the upper to the lower border in a direction giving the maximum measurement of the approximate thickness of the liver, varied between 10 and 14 centimeters. These are approximately the figures previously established by Pfahler (9). Normally, the right lobe of the liver constitutes most of the liver shadow, the left lobe being practically invisible and obscured by the spine. Ascites causes the liver to appear smaller than it actually is. The splenic shadow normally covers an area of two intercostal spaces, extending usually from the ninth to the eleventh rib. It is often less distinct than that of the liver because of the constant presence of gas in the stomach and colon. Our experience has shown us, therefore, that it is only within certain limits that deviations in size from the normal and from time to time are reliable. Even the shape of the liver and spleen may vary in films taken at different times. Considerable experience is therefore necessary before one learns not to attach too much importance to moderate variations in shape and size.

USES OF HEPATOSPLENOGRAPHY

While much information can often be obtained by the study of films alone, it is only proper that all of the clinical findings should be taken into consideration at the same time. This rule, of course, applies to roentgenology in general.

In a previous article (8), we concluded that the method is of value as follows:

1. In determining the nature of a mass in the upper part of the abdomen.
2. To determine the presence and kind of hepatic disease (atrophic cirrhosis, hypertrophic cirrhosis, syphilis of the liver, metastatic malignant lesions, primary tumor, abscess, cyst, and amyloidosis).
3. To ascertain whether metastatic le-

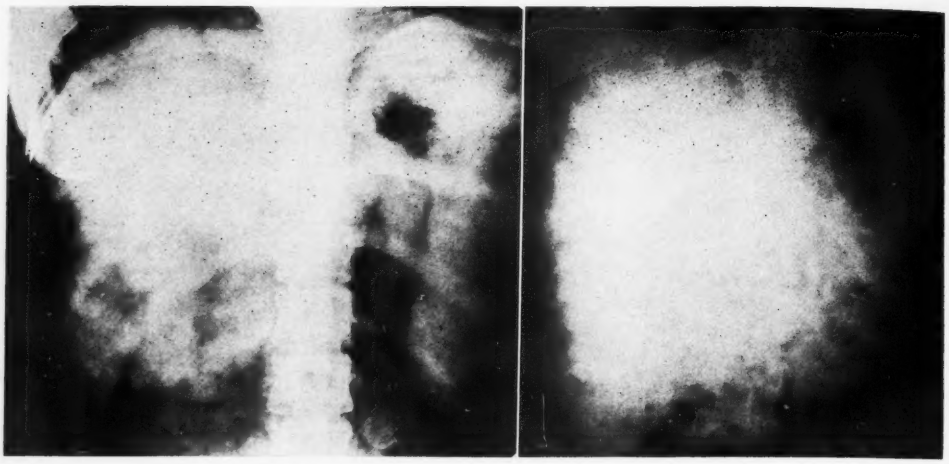

Fig. 3. Fig. 4.

Fig. 3. Hepar lobatum. The liver is enlarged and lobulated. Splenomegaly. The patient is in fair general health, nearly four years later (Case 3).
Fig. 4. Extensive carcinomatous metastases in the liver. Both lobes are greatly enlarged.

sions are present in the liver if operation is contemplated for carcinoma.

4. To demonstrate rupture of the liver or spleen.
5. To determine the cause of jaundice (whether intrahepatic or due to obstruction of the common bile duct).
6. To follow the progress of hepatic or splenic disease.
7. To demonstrate whether a lesion is above or below the diaphragm.
8. To diagnose ascites.
9. To study diseases of the spleen.

Inasmuch as our experience has been much greater since the publication of this paper, we shall discuss each of these points in the light of such extended experience.

1. It occasionally happens that clinicians are not able to determine whether a mass in the upper half of the abdomen is the liver or spleen or something else. From time to time we have employed hepatosplenography in order to settle this point. In most cases it has been possible definitely to state whether the liver or spleen is involved. In only one case were we definitely wrong in this connection. The liver was thought to be considerably enlarged, but operation showed that the mass felt was an old appendiceal abscess which had pulled the liver downward and tilted it so that the shadow actually was larger than normal.

2. Perhaps the greatest use of hepatosplenography is for the purpose of determining diseases of the liver.

Atrophic Cirrhosis.—We believe that cirrhosis of the liver may be detected by this procedure before other methods of diagnosis reveal it. In some cases the liver shadow is smaller than normal and diffusely mottled, with small areas of opacity in a background of greatly lessened density (Fig. 2). The left lobe of the liver, however, may appear to be definitely enlarged, particularly when compared with the right. The spleen is practically always moderately enlarged. In other cases the liver may appear to be normal in size but either very finely mottled or casting a homogeneous shadow of definitely reduced density. These two appearances are dependent upon the architecture of the fibrous replacement of hepatic tissue, fibrous tissue not containing reticulo-endothelial cells.

Hypertrophic Cirrhosis.—When regeneration is rapid the liver may become quite

large, and in such an event the reticuloendothelial cells containing the thorium dioxide are diffused in a large mass of parenchyma. Consequently, the enlarged organ casts a homogeneous shadow of lessened density, sometimes with a suggestion of mottling. The enlargement seems to involve mainly the right lobe of the liver, but this is more apparent than real. The spleen also is moderately enlarged.

Syphilis of the Liver.—Lobulation of the liver due to the healing of gummatous hepatitis (hepar lobatum) gives a characteristic appearance (Fig. 3). There is gross deformity and lobulation, frequently associated with mottling of relatively large areas. Syphilitic cirrhosis of the Lænnec type, however, cannot be distinguished from atrophic cirrhosis due to other causes. The spleen may appear to be quite large.

Metastatic Malignant Lesions.—When present in moderate number and of more than microscopic size, these lesions usually are readily observed in the hepatosplenograms. In cases in which the lesions are few and small, the liver may not be enlarged, but when there is extensive involvement the liver may become tremendously enlarged, both right and left lobes (Fig. 4). There are multiple rounded areas of varying sizes and of greatly reduced density, representing malignant tissue, which usually does not contain reticuloendothelial cells. These areas are usually surrounded by a halo of increased density (Fig. 5). The spleen is usually not enlarged.

Primary Tumor.—Diffuse primary carcinoma of the liver is difficult to differentiate by roentgen appearance alone from extensive metastatic involvement. The more rare single primary tumors are suggested by a large area of reduced density, with a somewhat irregular but usually fairly sharp outline in an enlarged organ. The halo of increased density is usually lacking. The spleen is not enlarged.

Abscess.—Our experience with hepatosplenography in this condition is limited to one case. Both solitary and multiple abscesses should easily be noted, and when taken in conjunction with the clinical picture the diagnosis of the roentgenogram should be easy. The edge of the defect is "fuzzy."

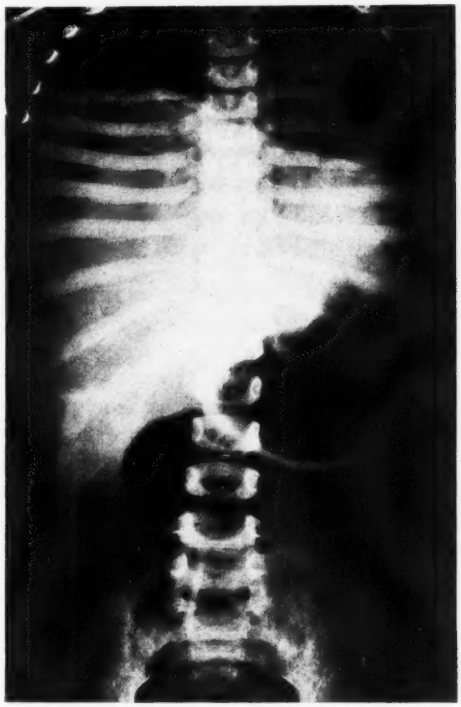

Fig. 5. Roentgenogram of a child, three years old (Case 5). Large carcinomatous metastasis may be seen in the left lobe of the liver; also, smaller nodule with a halo.

Cyst.—The same comment may be made in regard to cyst as to abscess except that the edge of the defect is sharper.

Amyloidosis.—The roentgen appearance of amyloidosis is almost identical with that of hypertrophic cirrhosis of the liver, but there is not the slightest suggestion of mottling.

Other Diseases of the Liver.—Such conditions as acute catarrhal jaundice, toxic or infectious hepatitis, and passive congestion of the liver produce nothing definitive in the hepatosplenogram. Focal necrosis may be suggested by the presence of small vacuoles.

3. We consider the use of thorium dioxide for determining whether or not meta-

stases are present in the liver as one of the very most important indications for the method. The diagnosis of this point has been wrong in exceedingly few cases. We are continuing to use this method almost as a routine for this purpose.

4. While rupture of the liver or spleen is determinable by hepatosplenography, our experience has been small and limited to two cases. For determining this point only 25 c.c. of the solution need be injected, and films may be taken as soon as two or even one hour thereafter. However, 50 c.c. would cast better shadows.

5. Further experience has shown that it is very rare to be able to determine the cause of severe jaundice not due to cirrhosis or associated with metastases. In chronic cases it may be possible to demonstrate the dilatation of the intrahepatic bile ducts.

6. Our original belief in regard to the value of hepatosplenography in determining the progress of hepatic disease by means of films taken at intervals of months or years has been greatly altered by the fact that changes in the architecture of the shadow occur as the result of partial elimination of the metal after the lapse of a few years. These changes will be described later. However, progression may at times be determined, as in cases of cirrhosis. It is probable also that metastases developing in a liver previously normal might readily be detected. We have had no experience in this connection.

7. In an occasional case it may be possible to obtain some help in determining the position of the diaphragm. This is probably not a very important field for hepatosplenography.

8. Ascites is easily detected by the method, in that the liver and spleen are separated from the lateral walls of the diaphragm.

9. We have come to the conclusion that hepatosplenography is of very little value in the diagnosis of diseases of the spleen.

CONTRA-INDICATIONS TO HEPATOSPLENOGRAPHY

Our experience has shown that there are no contra-indications yet established for the procedure. We have used the solution in cases of almost every kind without observing any definite deleterious effect. A number of our patients had severe jaundice of various durations and causes. Even in cases of acute hepatitis damage to the liver apparently has not resulted. We doubt also the suggested contra-indication of pulmonary tuberculosis, since the animal experimentation upon which this assumption was based has been found to be faulty.

In general, although we consider hepatosplenography harmless, it should not be used unless more simple methods of diagnosis fail. Some of the cases originally selected would not to-day be used, but in the beginning information was essential.

STUDY OF THE FIRST 200 CASES

A careful follow-up study has been made of the first 200 patients for whom thorium dioxide was employed. Of these, 47 are known to be living, and 36 have actually been re-examined both roentgenographically and generally. Bromsulphthalein tests of liver function and other studies as indicated have also been performed in a considerable number of cases. Of the living patients, confirmation of the clinical and roentgenological diagnoses was obtained in 10 instances either by biopsy of the liver or by celiotomy. Reports of those not actually examined have been received from the patients by social service workers or from the physicians involved. One hundred thirty-four patients are known to be dead, and the actual or approximate time of death is known in all. Definite diagnoses were obtainable in 73 (56 by necropsy, 15 by biopsy, and 23 by celiotomy). Nineteen patients could not be located, but a number of these are assumed to be living on the basis of their known pre-existing conditions (Table I).

Although the diagnoses in the vast majority of both living and dead patients in whom confirmation was not obtained were undoubtedly correct on the basis of clinical studies and roentgenograms, we shall discuss from the standpoint of accuracy of diag-

TABLE I.—GENERAL SURVEY OF 200 CASES WITH HEPATOSPLENOGRAPHY

Status of Patients		Necropsy	Biopsy	Celiotomy
Living	47	0	3	9
Dead	134	56	12	9
Untraced	19	0	0	5
Total	200	56	15	23

TABLE II.—DIAGNOSTIC ACCURACY OF HEPATOSPLENOGRAPHY IN 73 PROVED CASES

Correct	67		
Incorrect	6	Metastatic lesions in liver unsuspected	4
		Cirrhosis of liver not diagnosed	1
		Primary carcinoma diagnosed metastatic carcinoma	1
			6

nosis by hepatosplenography only those cases in which confirmation was obtained.

The interpretation of the hepatosplenograms was proved to be correct in 67 of the 73 cases. Among the six cases wrongly diagnosed on this basis, there were four in which metastases were not apparent in the films but in which some very small ones were found to be present at necropsy. In another case cirrhosis of the liver was found to exist which had not been previously diagnosed. In still another, primary carcinoma of the liver was found but metastatic carcinoma had been diagnosed (Table II).

The value of hepatosplenography in the whole group of 200 patients is indicated by the following figures:

1. The clinical diagnosis was confirmed in 61 cases.
2. The diagnosis was made from the hepatosplenograms in 49 cases.
3. The procedure was used to eliminate or to establish the presence of metastases in the liver in 46 cases.
4. The method was of no help in making the diagnosis, or was of negative value in 35 cases.
5. The diagnoses made on the basis of the films were wrong in six cases.

Therefore, hepatosplenography was of definite value in the study of 156 of the 200 cases.

The majority of the 200 patients were suffering from some fatal malady. In 52 instances, the diagnosis of cirrhosis of the liver of one type or another was made either clinically or by more definite methods. Carcinoma of some organ was present in 58 cases, with metastases occurring in the liver in 38 cases. Leukemia of some type existed in 10 cases. Instances of other serious diseases occurred in smaller numbers.

REVIEW OF LIVING PATIENTS

The 47 patients who have received thorium dioxide and are still living were in the following age groups at the time of administration: First decade, 5; second decade, 1; third decade, 5; fourth decade, 14; fifth decade, 10; sixth decade, 6; seventh decade, 4; eighth decade, 2. The youngest patient was three years old, and the oldest 74 years old. There were 25 females and 22 males.

Some of the 26 different diagnoses made in this group of 47 patients were as follows: Lænnec's cirrhosis (10 cases); syphilis of the liver (4 cases); hypertrophic cirrhosis of the liver (3 cases); chronic lymphatic leukemia (2 cases); myeloid leukemia (1 case); acute catarrhal jaundice (1 case); sickle-cell anemia (3 cases); splenic anemia (1 case); obstruction of the common bile duct (1 case); purpura hemorrhagica (1 case); left lobectomy for liver abscess (1 case); sarcoma of the leg with metastases to the liver (1 case). The other diagnoses were of various diseases of one case each, in which the liver and spleen were eliminated as part of the morbid anatomy.

The lengths of time elapsing between the administration of thorium dioxide and March 15, 1936, were as follows: Less than one year, seven; between one and two years, seven; between two and three years, eight; between three and four years, 11; between four and five years, 14. The first patient injected is still living and well, in spite of chronic lymphatic leukemia four years and nine months after the injection of 60 c.c. of thorium dioxide sol.

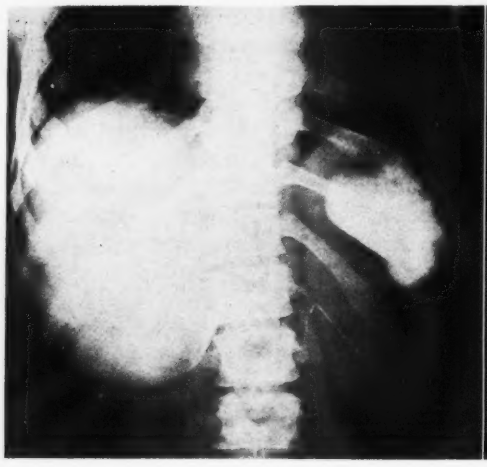

Fig. 6.

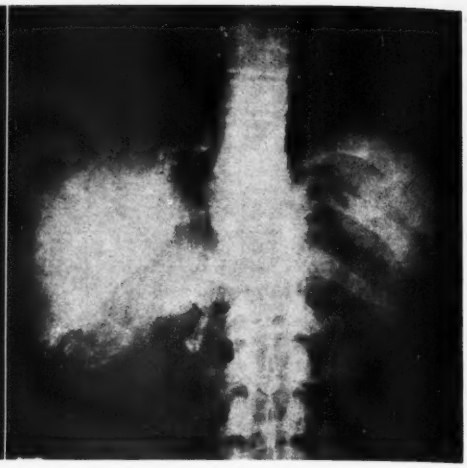

Fig. 7.

Fig. 6. There is seen an absence of the left lobe of the liver due to lobectomy for solitary abscess. The spleen is small, irregular, and dense.

Fig. 7. Hepatosplenogram taken nearly four years after the injection of thorium dioxide. Syphilitic cirrhosis (Case 8). Lobulation of liver. The fine linear mottling is due to contrast medium in the lymphatics of the liver. The opaque masses between the liver and spine are lymph nodes containing mobilized thorium dioxide.

RE-EXAMINATION OF LIVING PATIENTS

Of the 47 patients known to be living, 36 have been re-examined either at intervals or within very recent date of the writing of this report, both from the general clinical standpoint and by x-ray films of the abdomen. The bromsulphthalein test of liver function, selected as being the most generally useful test of liver function, was performed in 25 of these patients. Of these 25 patients, 12 had had acute disease of the liver or were suffering from chronic disease of that organ. Six were definite cases of cirrhosis, three were cases of syphilis of the liver, one was an unusual case of a man whose left lobe of the liver had been removed for solitary liver abscess (Fig. 6), one was a patient who had had acute hepatitis, and one was a patient who had been operated upon for obstruction of the common bile duct. This group of 12 cases is particularly significant in illustrating the harmlessness of stabilized thorium dioxide sol, both as to the effect of the prolonged presence of myriads of foreign bodies in the reticulo-endothelial system generally and in the liver particularly, and as to the question of radio-activity of the metal in the dosage employed. Two of the patients had been injected with thorium dioxide between one and two years previously, three between two and three years, two between three and four years, and four between four and five years. All but four of these patients are in excellent health subjectively, three are fairly well, and only one has progressed to a serious state of hepatic insufficiency clinically. Only four of the patients show retention of bromsulphthalein in the blood at the end of 30 minutes. Of the 13 other patients who did not have disease of the liver and on whom the bromsulphthalein test was performed, only one showed retention of the dye at the end of 30 minutes, and that was a patient with congestive heart failure and chronic passive congestion of the liver. The amount of dye recovered at the end of five minutes in these cases ranged from 30 to 70 per cent.

In the whole group of patients re-examined, particular attention was given to the question of intercurrent infection, for example, grippe, common respiratory infections, etc., and it was surprising to note the relative infrequency of these diseases in the

group. Only one patient had any serious intercurrent infectious disease (mastoiditis with operation and recovery). Of the children, three are in perfect health several years after the injection of thorium dioxide. The other two are in fairly good health, but one has xanthomatosis and the other has sickle-cell anemia.

REVIEW OF THE PATIENTS WHO HAVE DIED

All of the 134 patients who are dead were suffering from advanced, serious, usually chronic, but in three instances acute disease. Thirty-four were cases of advanced cirrhosis of the liver, 61 of carcinoma, seven of leukemia, five of malignant lymphoma, two of amyloidosis, two of tuberculous peritonitis, two of disseminated tuberculosis, two of congestive heart failure, two of pneumonia, and there was one case each of Felty's syndrome, septicemia following amputation of the leg, subphrenic abscess, uremia, empyema of the gall bladder, brain abscess, sickle-cell anemia, malignant melanoma, Paget's disease, rupture of the spleen, and coronary thrombosis. In six cases the diagnosis was undetermined. Most of the patients died within a year, but some lived longer and one lived even three years and six months (cirrhosis of the liver). Eleven of the patients now dead were rechecked roentgenographically after the injection of thorium dioxide, four within one year, five between one and two years, one between two and three years, and one between three and four years.

ROENTGENOGRAPHIC APPEARANCES ON RE-EXAMINATION

In 47 of the 200 cases, roentgenologic re-examinations were made, in most instances only once, but in several instances several times at intervals of months or years. In 20 cases there was relatively little change in the appearance of the roentgenogram. In a few of these there was definite diminution in the density of the hepatic and splenic shadows. Usually both organs were affected similarly, but occasionally one or the other was affected to a greater degree.

TABLE III.—ROENTGENOGRAPHIC APPEARANCES ON RE-EXAMINATION OF 47 CASES

No change or slight diminution in density of liver and spleen	20
Evidence of cirrhosis not present on first examination	2
Cases showing mottling of liver or (and) spleen	22
Cases showing visible lymph nodes near liver or (and) spleen	14
Cases showing both mottling of liver or (and) spleen and visible lymph nodes	10

Of the 20 cases, seven had been re-examined within one year, seven between one and two years, one between two and three years, and five between three and four years after the administration of the thorium dioxide. In two cases changes were noted in the liver which were additional aids in the diagnosis. In both, the liver had appeared normal on the first examination, whereas in the progress films definite evidence of cirrhosis was apparent. Both had been merely suspected of having cirrhosis at the time of the first examination (Table III).

In 26 cases definite evidence was shown on the films of mobilization or elimination of the thorium dioxide. This took the form either of mottling of the liver or spleen or both, or of the existence of visible lymph nodes either between the liver and the spine, or between the spleen and the spine. However, in only 10 were there both mottling of one or both of these organs and visible lymph nodes together. The mottling of the liver or spleen or both organs was present in 22 rechecked cases. The visible lymph nodes were present in 14 rechecked cases.

The shortest period of time after the administration of thorium dioxide that mottling was noted was one year and one month; the longest period was four years and 11 months. There was very little difference in the periods of time elapsing, however, between the cases with mottling and those without. For instance, there were seven cases without mottling in which the metal had been injected over three years before the re-examination. In the case of the patient with the longest time, namely, four years and nine months, there

was no mottling. In the cases in which there was mottling, both the liver and spleen were affected in nine, the liver alone in nine, and the spleen alone in five. In all cases in which both the liver and spleen were mottled, the thorium dioxide had been injected more than three years before.

Fig. 8. Hepatosplenogram, taken nearly four years after the injection of thorium dioxide. The liver and spleen are normal. The spleen is diffusely mottled. Visible lymph nodes may be seen between the liver and spine.

The mottling of the liver was of two types. In one, which occurred more often, there was a very fine, punctate, uniform mottling which was close-set and dimly apparent. In the other, the mottling took the form of small, distinct, linear and somewhat interlacing shadows not so closely set (Fig. 7). This latter type gave definitely the appearance of some opaque substance in the lymphatics of the organ. It also gave the definite impression of considerable reduction of the amount of the metal in the liver. Neither type of mottling would often be confused with that due to cirrhosis, since in the first type the mottling is much more compact and relatively indistinct, whereas the form of mottling seen in the second type had not been observed in any of our cases of cirrhosis at the time of the original examination.

The mottling of the spleen also took two forms. One form was very similar to that of the first form described for the liver; the other consisted of a larger type of rounded mottled areas from 1 to 1.5 mm. in diameter, distinctly separated one from the other and giving the organ the appearance of a honeycomb (Fig. 8). This type of mottling is occasionally seen in the spleen on the original examination after the injection of thorium dioxide.

The lymph nodes were visible on both sides of the spine near the liver and spleen in only three of the 14 cases in which the lymph nodes were visible. In 10 cases the lymph nodes were visible only between the liver and the spine, and in only one case were the lymph nodes visible between the spleen and the spine alone. These lymph nodes were usually quite distinct and quite dense, and were undoubtedly due to the presence of relatively large amounts of thorium dioxide in the nodes draining the

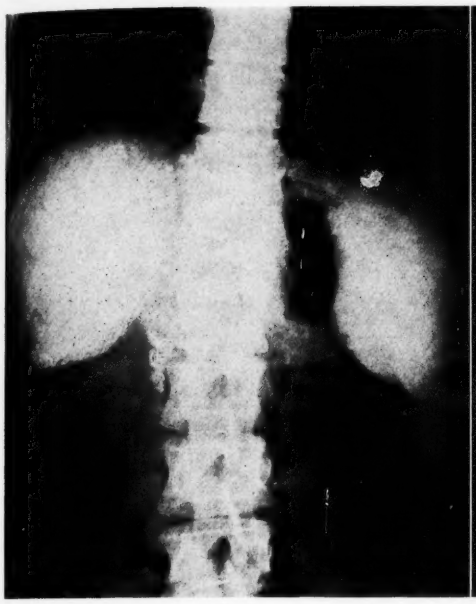

Fig. 9.

Fig. 10.

Fig. 9. Hepatosplenogram taken more than four years after the injection of thorium dioxide. Atrophic cirrhosis (Case 1). The right lobe of the liver decreased in size, whereas the left lobe enlarged. The spleen is slightly enlarged. The liver shows fine linear mottling due to contrast medium in the lymphatics of the liver. The spleen is finely mottled. The lymph nodes, containing thorium dioxide, are visible on the right side of the spine. Figure 10 is made from the original hepatosplenogram. The patient is in good general health.

Fig. 10. Case 1. The liver is small but its structure is not altered. The left lobe is somewhat enlarged. The spleen is normal. Figure 9 is a hepatosplenogram made more than four years later.

liver or the spleen, or both (Fig. 9). In four additional cases there was some question as to the visibility of the lymph nodes, as they were not definitely visible in any case in which the metal had been injected less than a year before. There was only one case in which it had been injected less than two years before. In the case which has gone four years nine months, the lymph nodes were visible only in the region of the porta hepatis. However, in many of the cases in which the lymph nodes were not visible considerable time had elapsed following the injection of the thorium dioxide. In fact, there were five cases in which the injection had been made four years or more previously. We feel justified in assuming, therefore, that the mobilization and, therefore, the elimination of thorium dioxide from the reticulo-endothelial cells of the liver and spleen is, on the whole, a slow process, and its rapidity varies considerably in individual cases. Just how long it would take in the majority of cases for all of the metal to be eliminated from the body or even from the liver and spleen is impossible to conjecture with any degree of accuracy.

It has already been stated that the resistance to infection in patients who have received thorium dioxide in the doses employed did not appear to be diminished. Nor was there any evidence clinically that there had been damage to the liver which could be attributed to the metal. In addition, there has been no evidence of radium poisoning in any of the patients up to the present time. Furthermore, in those few cases in which thorium dioxide had been injected erroneously, usually in small amounts, into the tissues surrounding the vein there has been no evidence of the development of sarcomas at that point.

PRELIMINARY REPORT OF HISTOPATHOLOGIC STUDIES OF 71 CASES[5]

The thorium dioxide in sections stained with hematoxylin and eosin appears as brownish-gray granules, especially in the liver and spleen. In the liver there are oval or round masses of these granules in the sinusoids; there is none in the liver cells and rarely very much in the connective tissue of the portal areas. The masses have the size and outline of the reticuloendothelial cells, but usually the granules are so abundant that the nuclei of these cells cannot be seen; however, in some cases they are less numerous, and the nuclei are distinctly visible.

In many of the cases the masses of granules are distributed quite uniformly through the liver lobule; in some, however, the masses tend to form groups anywhere in the lobule but at times in the central zone. In cases of chronic passive congestion, with atrophy of liver cells and widening of the sinusoids in the central zone, this grouping in the central zone may be more apparent than real.

In none of the cases is there the slightest evidence of any injury to the liver cells, irrespective of the length of time the metal has been present. Even in the cases in which the masses of granules are grouped in the sinusoids, the liver cells lying next to and around these groups are normal in size, appearance, and staining properties, and do not contain fat or blood pigment. There is no cellular reaction or fibrosis in the liver in the region of these masses, indicating any effort to wall off the masses.

The same appearance exists in the splenic pulp, except that there the granules are frequently seen as blotches and patches, in addition to the oval or round compact masses. There is not nearly as great accumulation of the granules in the splenic corpuscles as in the pulp, and there is very little in the connective tissue of the trabeculæ and capsule. At times, however, the masses of granules outline the fibrous trabeculæ and occasionally the blood vessels. There is no evidence of any cellular reaction or fibrosis in the spleen in the region of these masses.

Relatively small amounts of thorium dioxide are present in the other organs and the lymph nodes. Again, there is no evidence of any reaction that can be attributed to the presence of the metal.

[5] By Dr. Eugene R. Whitmore. Complete report will appear later.

REPORTS OF CASES ILLUSTRATING THE HARMLESSNESS OF HEPATOSPLENOGRAPHY

Case 1. A white woman, I. D., aged 49 years, was admitted to the Georgetown University Hospital on Nov. 20, 1931, with jaundice of four weeks' duration and epigastric pain of two weeks' duration. The van den Bergh reaction before operation was 37.5 mg. per 100 c.c. of blood. Although considered by the medical consultants to be a case of hepatitis, the surgeon believed an exploratory operation advisable. This was performed on Dec. 5, 1931. Obstruction of the common bile duct was not found, but the liver did not appear normal. Cholecystotomy was performed. Report of biopsy of the liver was as follows: "There is complete disappearance of the liver lobules, only the ducts remaining in the specimen submitted. The latter are dilated and lined by regular epithelium. The liver parenchyma has been replaced by firm connective tissue, apparently of long standing. Evidently there has been superimposed upon this chronic fibrosing process an acute one characterized by large areas of leukocytic infiltration." The jaundice slowly subsided, the van den Bergh reaction reaching normal by Feb. 10, 1932. A bromsulphthalein test of liver function performed two weeks later showed 50 per cent retention after five minutes and none at the end of 30 minutes. On Feb. 4, 1932, after injection of 60 c.c. of stabilized solution of thorium dioxide, hepatosplenograms were made. These showed the liver to be quite small, the medium well concentrated, and no apparent alteration of structure (Fig. 10). The vessels were

visible in the right lobe, at the lower edge of which there was a smooth, sharp defect, which had the appearance of surgical intervention. The spleen appeared to be normal in size and density, and there was an accessory spleen. This patient has been re-examined at intervals and was last seen on March 23, 1936. Except for occasional attacks of "indigestion" and nervousness she has been quite well, and the physical examination has been essentially negative. A bromsulphthalein test on Nov. 15, 1935, showed retention of 40 per cent after five minutes and none at the end of 30 minutes. A hepatosplenogram made Oct. 22, 1932, over eight months after the first, showed the liver shadow somewhat less dense and very finely mottled. The right lobe was about the same size, but the left lobe was somewhat enlarged. The spleen was about the same size but slightly more dense. Another film made Jan. 14, 1933, showed evidence of ascites. The liver was definitely mottled, and the spleen was somewhat enlarged. A film made on March 16, 1936, more than four years after the original film, showed definite diminution in the density of the liver and fine linear markings of metal in the lymphatics (Fig. 9). The right lobe was small and the left lobe seemed to be as large as the right. In the region of the porta hepatis there were dense opacities undoubtedly representing lymph nodes containing thorium dioxide. The spleen was of the same size and very finely mottled. This patient undoubtedly has cirrhosis of the liver, but this was demonstrated before the injection of thorium dioxide, and four years of moderately good health without laboratory evidence of impairment of liver function have followed the injection of the metal.

Case 2.[6] The patient, M. A., a white woman aged 28 years, was admitted to the Georgetown University Hospital on Sept. 22, 1931, complaining of severe weakness of two weeks' duration, with nausea and occasional vomiting after meals, moderately severe and fairly constant lower abdominal pain, and profuse vaginal discharge. The general physical examination was essentially negative except for some evidence of pelvic inflammatory disease and moderately severe anemia. Four days after admission she received 500 c.c. of citrated blood with no apparent reaction, but three days later it was noted that she was slightly jaundiced. Shortly thereafter, the van den Bergh reaction was reported as prompt direct with 5 mg. of the bilirubin per 100 c.c. of blood, and ten days later the quantitative reaction showed 25 mg. per 100 c.c. After another 10 days it had risen to 35 mg. per 100 c.c. At this time, in view of the increasing intensity of the jaundice and a history of recurring attacks of severe upper abdominal pain which had occurred shortly before admission, it was decided to perform a laparotomy to determine whether cholelithiasis with obstruction of the common bile duct existed. Stones were not found. The liver was normal in size and shape but seemed unusually firm. The spleen was somewhat enlarged. There was a moderate amount of bile-stained fluid in the abdominal cavity. A section was removed from the liver edge for biopsy. The ascites, which had not been evident clinically, increased greatly during the first few post-operative days and drained freely through the incision. Evidence of ascites persisted for about two weeks and then gradually disappeared. The van den Bergh reaction showed a gradual decline following the laparotomy. The readings at approximately weekly intervals were 15 mg., 7.8 mg., and 2 mg. per 100 c.c. of blood. The bromsulphthalein test of liver function done after the ascites had disappeared showed 75 per cent retention in five minutes and 15 per cent in 30 minutes. The stools showed bile throughout the course. Biopsy of the liver showed the following: "There is a slightly thickened capsule and considerable periportal fibrosis. Marked edema and round-cell infiltration obscure the normal hepatic picture; also, there is a pronounced regenerative

[6] Reported as a case of jaundice with ascites and recovery by J. R. Cavanagh, M.D., in Med. Ann. of the District of Columbia, 1935, **4**, 322.

process. The picture is that of a subacute inflammatory process." Hepatosplenograms made on Dec. 10, 1931, after the injection of 60 c.c. of thorium dioxide solution, showed the liver "length" to be 25.5 cm. and the "thickness" to be 13.5 cm., which is above the average in size. There was a moderate degree of mottling which gave the appearance of early cirrhotic change. The spleen was normal in size. The temperature was normal throughout the course in the hospital, as were the pulse and respiration, except when the postoperative hemorrhage occurred. Treatment consisted chiefly of transfusions and administration of large amounts of glucose solution intravenously and subcutaneously. Since that time the patient has been under observation and has been fairly well except for attacks of severe abdominal distress simulating partial intestinal obstruction occurring at intervals of from three to four months and lasting about a week. She is otherwise well, has been married twice, and is able to perform all of the duties of a nurse. On Sept. 11, 1935, roentgenographic films of the liver and spleen were again made, nearly four years after the first. These showed no appreciable diminution in the intensity of the shadows. The liver and spleen were approximately the same size as at the previous examination, except for a slight decrease in the volume of the spleen. The liver showed some gross and also fine granular mottling. The spleen had a peculiar honeycomb-like appearance. There was an opaque meshwork beneath the lower part of the right lobe of the liver, which evidently represented the medium in the lymphatic vessels. There were also deposits, probably of thorium dioxide, in the hepatic and splenic lymph nodes. A bromsulphthalein test at this time showed 70 per cent retention after five minutes but none at the end of 30 minutes.

Case 3. A white woman, D. M., aged 36 years, entered the Out-patient Department of Georgetown University Hospital on Oct. 15, 1931, complaining of "indigestion" and pain in the hypochondriac regions. Twelve years previously, while suffering from the same symptoms, she had been found to have syphilis, for which she had been treated intermittently. Physical examination showed slight jaundice, moderate enlargement of the thyroid gland, and considerable enlargement of the liver, which was firm and irregular. The spleen was also moderately enlarged. The Wassermann and Kahn tests of the blood were four plus. There was moderate anemia. Antisyphilitic treatment was begun with bismuth and mercury. On Feb. 15, 1932, the bromsulphthalein test of liver function showed 45 per cent retention at the end of five minutes and none after 30 minutes. The van den Bergh reaction was indirect, with 1.25 unit. Hepatosplenograms made on March 22, 1932, after the injection of 75 c.c. of stabilized thorium dioxide sol, showed considerable enlargement of both liver and spleen (Fig. 3). The former had large lobulations, the latter was homogeneous. The appearance was definitely that of hepar lobatum. After several months the patient failed to return for treatment. She was not seen again until Jan. 18, 1936. In November, of 1934, she had had attacks of pain in the upper sternal region associated with dyspnea. Antisyphilitic treatment was given in a physician's office. In January, of 1935, she became pregnant and developed edema of the extremities and hypertension which went as high as 225 systolic. In October, of 1935, she gave birth to an apparently normal infant, whom she was still nursing. The edema had not entirely disappeared. The attacks of upper sternal pain and dyspnea continued to recur at intervals, but she said she felt well and was working. Physical examination showed the liver to be somewhat larger than before, and firm and nodular. The spleen was about the same size as in October, 1931. Hepatosplenograms made on Jan. 18, 1936, nearly four years after the first, showed some reduction in density of the liver shadow, and an irregular, fine mottling. The lobulations were not as distinct as before. The spleen was of ap-

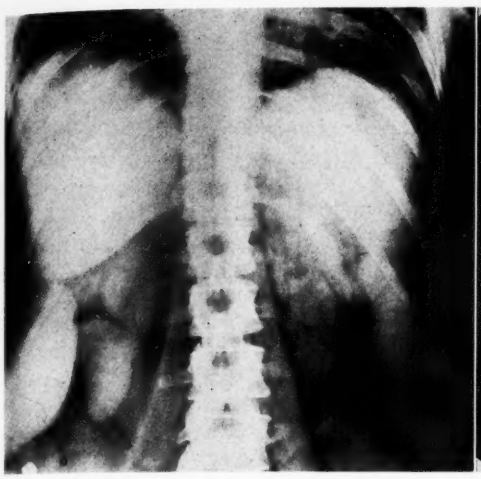

Fig. 11.

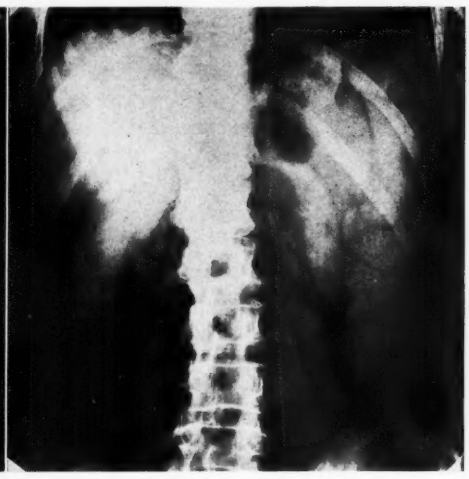

Fig. 12.

Fig. 11. Case 4. Original hepatosplenogram. Chronic lymphatic leukemia. The liver is normal. The spleen is moderately enlarged.

Fig. 12. Case 4. Hepatosplenogram, made nearly five years after the injection of thorium dioxide. There is a moderate reduction in density of the liver and spleen. Same appearance otherwise as in the original film. A small lymph node is visible at the porta hepatis. The patient is in good health.

proximately the same size and density as originally. There were visible lymph nodes between the spleen and the spine. The patient would not remain for laboratory tests.

Case 4. The patient, M. C., a white woman, aged 58 years, was first seen in October, 1930. She was complaining of abdominal "gas," with eructations and some gastric distress. Several months previously she had been found to have chronic lymphatic leukemia, and x-ray therapy had restored the hemogram to normal. The physical examination was negative except for moderate splenomegaly. The symptoms responded to symptomatic treatment. On July 11, 1931, hepatosplenograms after the injection of 60 c.c. of stabilized thorium dioxide sol showed an apparently normal liver; the spleen was moderately enlarged (Fig. 11). The kidneys were well visualized, an occasional occurrence when thorium dioxide is used. The patient continued teaching school, in good health. In April, 1935, however, the hemogram again showed evidence of lymphatic leukemia, and x-ray therapy was repeated. Hepatosplenograms, made on April 25, 1935, showed the liver shadow to be somewhat less dense than originally. The spleen was somewhat larger and less dense than the liver. A small lymph node at the porta hepatis was visible. In August, 1935, the patient was well and the hemogram normal. The same was true in November, 1935, and again on April 10, 1936. On the latter date, just four years and nine months after the injection of thorium dioxide, hepatosplenograms showed the same condition existing as on April 25, 1935 (Fig. 12). The liver and spleen were well demonstrated and of only moderately reduced density compared with the original films. Some of the contrast medium had been accidentally injected into the tissues of both arms. These areas were hardened tumefactions, but there was no evidence of sarcomatous or other change. The hemogram was essentially normal.

REPORT OF CASE ILLUSTRATING THE VALUE OF HEPATOSPLENOGRAPHY TO DETERMINE PRESENCE OF METASTASES

Case 5. The patient, G. T., a negro girl aged three years, developed a large

mass in the left side of the abdomen. This was determined to be a neoplasm of the left kidney, which was removed and found to be a Wilms' tumor. Seven weeks later, 12 c.c. of stabilized thorium dioxide sol was injected intravenously and a hepatosplenogram made (Fig. 5). This showed the liver to be greatly enlarged downward and to the left. In the right lobe there was a large, more or less homogeneous, rounded area of lessened density. Within this area there was another round area of diminished opacity surrounded by a halo. Only a small portion of liver tissue remained below this. The left lobe of the liver was somewhat enlarged. The spleen appeared normal. Celiotomy a week later revealed ascites and confirmed the presence of large metastatic lesions in the liver. The child died three weeks later.

REPORT OF CASE ILLUSTRATING THE DIAGNOSTIC VALUE OF HEPATOSPLENOGRAPHY

Case 6. A negress, H. M., aged 52 years, entered Gallinger Municipal Hospital on June 25, 1933, complaining of nausea and vomiting of four months' duration. There had also been more or less constant epigastric pain and two attacks of probable hematemesis. Loss of weight and strength was also noted. Chronic alcoholism was admitted. The patient was emaciated, and there were many râles over both lung-fields. Tenderness was elicited in the epigastrium, but masses were not palpable. There was definite anemia, and the Kahn test of the blood was four plus. A roentgenogram of the chest showed evidence of tuberculosis, but the sputum was negative. A gastrointestinal x-ray study was thought to reveal evidence of a lesion of the stomach. Hepatosplenograms made on July 3, 1933, after the injection of 75 c.c. of stabilized thorium dioxide sol, showed the left lobe of the liver to be enlarged and the whole organ to be diffusely mottled, as in cirrhosis. The spleen was not definitely enlarged. Celiotomy, on July 26, did not reveal a lesion of the stomach but showed the liver to be enlarged, lobulated, mottled, and scarred. The patient was re-admitted to the Hospital in October, 1935. She had improved greatly, but recently frequent attacks of epigastric pain and vomiting had recurred. The physical examination was the same. There was 5 per cent retention of bromsulphthalein at the end of 30 minutes. Hepatosplenograms made on Oct. 15, 1935, more than two years after the first, showed essentially the same condition as originally, but the granulation of the liver was much more definite (Fig. 2). The patient was discharged three weeks later, greatly improved.

REPORTS OF CASES ILLUSTRATING THE DIAGNOSTIC VALUE OF "PROGRESS FILMS"

Case 7. A white man, P. S., aged 45 years, had had pleurisy with effusion in the latter part of 1931. While still ill in April, 1932, he developed gangrenous appendicitis. After recovery from this he continued to have a little fever daily, some dyspnea, cough, and abdominal distention. In September, 1932, there was definite ascites and hepatomegaly. With treatment, these abnormalities slowly disappeared in the next six months but the patient continued to feel weak. In December, 1933, the bromsulphthalein test of liver function showed 80 per cent retention in five minutes and 20 per cent after 30 minutes. Hepatosplenograms, made on Feb. 6, 1934, after the injection of 75 c.c. of contrast medium, were apparently normal. The patient continued to feel weak but had no definite symptoms. Hepatosplenograms, made on Sept. 9, 1935, a year and a half after the first, now showed a definite granular appearance of the liver, and the left lobe was seen to be considerably enlarged. There was no ascites. The diagnosis of cirrhosis of the liver was established. The liver function test showed 100 per cent retention of bromsulphthalein in five minutes and 20 per cent after 30 minutes.

Case 8. A negro, J. G., aged 55 years, was admitted to the Gallinger Municipal Hospital on June 1, 1932, complaining of

abdominal distention and weakness of several months' duration, with marked loss of weight. He had not used alcoholic beverages. Physical examination showed slight jaundice, some ascites, and moderate enlargement of the liver. The Kahn test of the blood was four plus. The van den Bergh reaction was mainly indirect, with 2.5 units. A hepatosplenogram, made on June 16, 1932, after the injection of 75 c.c. of contrast medium, showed the liver and spleen to be normal in size, contour, and position without evidence of organic change. Other diagnostic studies were negative. Syphilitic disease of the liver was suspected. The abdomen was tapped, with withdrawal of ascitic fluid, and antisyphilitic treatment was instituted. He got along fairly well except for mastoiditis in July, 1935. The size of the abdomen fluctuated from time to time. He was reexamined on Nov. 11, 1935, and again on March 30, 1936, in the Out-patient Department. There was no evidence of ascites. The liver was definitely enlarged, but the spleen could not be felt. Hepatosplenograms on both occasions, the last nearly four years after the original films, showed the liver somewhat smaller than before, with enlargement of the left lobe and definite lobulation very suggestive of hepar lobatum (Fig. 7). The liver was considerably less dense than before, and showed evidence of the thorium dioxide having migrated to the lymph channels. The spleen was slightly larger but of the original density. There was a questionable visible lymph node near the spleen. A bromsulphthalein test showed 100 per cent retention after five minutes and 30 per cent after 30 minutes. The diagnosis of hepar lobatum was now definitely established. The patient was living and in fair general health four years after ascites was known to have been present.

EXPERIENCE OF OTHER INVESTIGATORS

There are two schools of thought regarding the danger of hepatosplenography by means of thorium dioxide. Several investigators, including Anders and Leitner (10), Büchner (11), Shute and Davis (12), Cooke (13), Hanke (14), and Pohle and Ritchie (15), are rather opposed to its use, but, in our opinion, without sufficient evidence. Objections have generally been based upon animal experiments extending over periods of days, weeks, and months. Often the dosage employed was comparatively many times that necessary for hepatosplenography in man. The acute changes produced, such as necrosis, cloudy swelling, and atrophy in the liver, spleen, and lymph nodes, have caused the greatest comment, but with moderate dosage permanent damage to these organs has not resulted. Other workers, such as Radt (3 and 4), Irwin (16), Dickson (17), Kadrnka (18), Whitaker, Davis, and Murgatroyd (19), Tripoli, Haam, and Lehmann (20), Ravenna (21), Ericksen and Rigler (22), Tripoli (23), Hirsh and Morton (24), Robins and Goldberg (25), and Rigler, Koucky, and Abraham (26), believe it is a relatively harmless procedure. Naturally, most of these have urged caution until all danger of latent radio-activity has been excluded. Unfortunately Radt (27), whose experience is the longest, has left Berlin and has lost his records and access to his patients. He still believes the method to be without danger.

The experience of Rigler, Koucky, and Abraham (26) is very similar to ours. In November, 1935, they reported on the use of thorium dioxide in 175 patients studied over a period of three and one-half years. Their clinical material included mainly patients with malignant neoplasms, and all but 43 had died at the time of their report. Some had lived a number of years, but only two had lived more than three and one-half years. In the entire series there were only two serious reactions, and one was probably not due to the thorium dioxide. Liver function tests showed no evidence of impairment, and there was no evidence of increased susceptibility to infection. Histopathologic studies in 35 cases revealed few, if any, changes attributable to the presence of the metal or similar to those observed in animals examined soon after

the injection of very large doses. Repeated roentgenographic examinations in 22 cases from one to three and one-half years after the injection indicated little or no elimination, but redistribution of the metal into the lymphatics of the liver with extension into the hepatic lymph nodes was observed in almost all cases re-examined after a year or more had elapsed.

So far as we know no fatal reactions have resulted from the clinical use of the proper solution of thorium dioxide. The spontaneous rupture of the spleen reported by Büngeler and Krautwig (28) may have been due to its use, but we do not believe there is much proof for this assumption.

Various changes in the blood picture and in the bone marrow have been observed by some investigators working with animals, but clinicians have not observed more than transient and minor changes in the hemograms of patients.

SUMMARY AND CONCLUSIONS

A review has been made of 200 cases in which hepatosplenography with stabilized thorium dioxide sol was employed as a diagnostic aid during the past five years. The procedure was of value in 156 cases. The diagnosis was made almost entirely on the basis of the hepatosplenograms in 49 cases.

The use of thorium dioxide in the form and amounts used is apparently harmless. Although most of the patients studied had incurable and rapidly fatal diseases, 47 of the patients are known to be alive and in remarkably good condition months and years after the injection. Some of them have lived more than four years. A number of them have cirrhosis of the liver, but clinical studies including the bromsulphthalein test of liver function have showed remarkably little progression in the severity of the disease in most cases. The patients have showed no increased susceptibility to infection.

The thorium dioxide is eliminated very slowly. The shadows in the roentgenograms due to its presence in the liver and spleen show very little reduction in density after three and four years. However, after a variable length of time, usually more than two years, there may be evidence of mobilization from the fixed reticulo-endothelial cells of the liver and spleen to the lymphatics of these organs and to adjacent lymph nodes.

A preliminary histopathologic study of 71 cases indicates that the presence of the thorium dioxide has not caused appreciable organic changes.

It is predicted that hepatosplenography with stabilized thorium dioxide sol will come to be recognized as a valuable and essentially harmless diagnostic procedure.

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RADIATION THERAPY OF BONE TUMORS[1]

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IRRADIATION as a therapeutic agent has been used for bone tumors since radiation was first introduced into practice, but like many forms of medication its early use was purely empiric. As time has gone on, we have learned more and more about its effects so that we now have a fair idea as to what to expect when used in the various types of bone lesions. Experience has shown that in such a condition as giant-cell tumor its use alone results in a high percentage of permanent cures, while in other tumors, such as osteogenic sarcomas, the incidence of five-year curability is so low that it must be considered as a supplementary measure to surgery rather than a replacement procedure. Our knowledge along these lines has been accomplished by greater accuracy in diagnosis and our greater appreciation of radiosensitivity. Cells differ in their response to irradiation: those that disappear promptly with minimal dosages we term radiosensitive, while those that fail to show any change to amounts that are detrimental to the covering skin are termed radioresistant. It is apparent that many tissues fall between these two extremes, consequently response is determined by differential effects on cell types that make up the bulk of the tumor. It is easy to conceive that such terms as "radiosensitive" and "radioresistant" must be purely relative and have their basis in morphologic studies. Therefore, accuracy of histologic diagnosis is an absolute essential in the correct estimation of what may or may not be accomplished by irradiation. Biopsy material must then be the basis for such an opinion. The method of doing this, whether by aspiration or open operation, is a question to be decided by the clinician; an important point to remember is that the material obtained be sufficient for the pathologist to make a thorough study on which to give his opinion. Even under such conditions the diagnosis may still be in doubt. Here it is justifiable to resort to the therapeutic test of radiation and the noting of its effect which may point the way to a correct diagnosis. Indeed, it was not alone by histologic and radiologic studies but by radiation response that Ewing was able to place endotheliomas in a class by themselves. With this brief introduction we shall discuss the response and results obtained in the treatment of the many types of bone tumor.

Bone tumors are benign and malignant: in the benign class we have osteochondromas, giant-cell tumors, and bone cysts.

Osteochondromas, or exostoses, are of no importance from a radiotherapeutic standpoint since they show no response. They are a surgical problem and are of interest to the radiation therapist only when they undergo sarcomatous changes. When this happens their response is similar to the chondrosarcomas.

Giant-cell tumors are relatively sensitive to radiation. Not all are equally so, since this is a tumor of many variants; some contain cartilage, while others have xanthomatous elements, and at times one is malignant. Our experience, as well as the experience of others, points to the fact that the treatment should be moderate in amount and should be given in two or three series spread over a period of at least a year. In other words, the aim is to produce a slow sclerosis and calcification in a benign tumor. On the other hand, high doses rapidly given as is done in malignant conditions may be followed by a sudden increase in the size of the tumor, with redness of the skin, local temperature, and aggravation of the pain already present.

[1] Read before the Radiology Section of the California Medical Association at the Sixty-fifth Annual Session, Coronado, May 25–28, 1936.

To the novice this indicates activity on the part of the tumor, when in reality it means rapid central liquefaction of the tumor which may be followed by a pathologic fracture in the weight-bearing bones. This has been termed the "negative phase"; it passes off in a few weeks and then calcification is slowly accomplished. Those patients who have recurrences after previous curettage and cauterization show a slower response than do the primary group. The explanation of this is not clear but it probably is due to a disturbed vascularity. Table I gives our experience with radiation in this type of tumor.

Bone cysts are strictly not bone tumors, but when no biopsy or exploration has been done they may be confused with giant-cell tumors. They show little, if any, response to irradiation. However, such lesions recur after surgery and cauterization and in instances of this kind irradiation is of value in preventing recurrences. The following history is of interest.

A. N., aged 5 years, was referred to us in August, 1933, by Dr. Harold Crowe, of the Orthopedic Hospital. Two weeks previously he had had his third operation on a bone cyst of the femur. Following a total of 1,200 r, which was given through three ports in two weeks' time, the area calcified. A recent letter from Dr. Crowe states that the patient has now been well three years following the irradiation given him.

TABLE I.—GIANT-CELL TUMOR OF BONE

Name Date	Sex Age	Region	Duration	Pathology	Operation	Recurrence	Metastasis	Radiation	Symptom-free
B. 1920	F. ?	Sup. maxilla left	2 years	Giant-cell tumor	Exploration and curettage 3 weeks before	No	No	Radium around the region	Well, 16 years
R. 1921	F. ?	Sup. maxilla left	6 months	Giant-cell tumor	Exploration and curettage twice	Yes Once	No	Radium; x-ray	Lost track of
K. 1924	M. 18	Right radius lower end	6 months	No	No	No	No	X-ray	Lost track of
B. 1924	M. 26	Sacrum inner surface	12 years	No	No	No	No	X-ray, 1 series	Six months later free from pain; mass smaller. Lost track of
R. 1924	M. 14	Left first metatarsal	2 years	Giant-cell tumor	Yes; biopsy	No	No	X-ray, 1 series	Well
W. 1926	M. 44	Lower right fibula	3 weeks	No	No	No	No	X-ray, H. V., 3 series	One and one-half years later. Lost track of since
W. 1927	F. 34	Right lower radius	4 months	Giant-cell tumor	Explored and curetted; did not wait for x-ray effects	No	No	Pre-op. x-ray, 1 series	Well, 9 years
K. 1929	M. 25	Right first metacarpal	1 year	No	No	No	No	X-ray, 2 series	One year. Lost track of since
J. 1931	F. 7	Right malar bone	3 months	Giant-cell tumor	Biopsy	No	No	X-ray, 2 series: H. V. 1; S. V., 1	Well, 5 years
H. 1935	M. 5	Left upper humerus	3 months	Giant-cell tumor	Curettage; had pathologic fracture	No	No	X-ray, 1 series	Well, 9 months

TABLE II.—CHONDROSARCOMA

Name Date	Sex Age	Region	Duration	Pathology	Operation	Recurrence	Metastasis	Radiation	Symptom-free	Dead After
C. 1918	M. ?	Ilium	8 years	None	No	No	No	Many series x-ray—controls pain	For 26 years—at present has difficulty in getting around	
M. 1923	M. 38	Head left femur	13 years	None	No	No	No	X-ray, 2 series: H. V., 1923; S. V., 1935	13 years	
T. 1926	M. 15	Lower end right femur	3 months	Chondrosarcoma	Exploration	?	?	Radium buried in mass	Lost track of	
H. 1927	M. 30	Sixth rib right side at chondro-costal junction	2 years	None	No	?	?	Radium pack	Lost track of	
M. 1929	F. 37	Left ilium	6 months	Chondrosarcoma	After x-ray therapy chiselled off part of growth twice	Yes		X-ray, H. V., 5 series		4 years
M. 1930	M. 50	Cervical vertebra	1 year	None	No	No	No	X-ray, 3 series: H. V., 2; S. V., 1	6 years	
R. 1934	M. 52	Left femur at acetabulum	2 years	None	No	No	No	X-ray, 2 series		
B. 1935	M. 57	Right ilium	4 years	Chondrosarcoma	Three operations at Mayo Clinic. Fourth done	Yes	No	Radium needles inserted at fourth operation. S. V. x-ray series	1 year	

In the malignant group of bone tumors we have chondrosarcomas, endothelial myelomas, multiple myelomas, osteogenic sarcomas, hemangiomas, and metastatic tumors.

Chondrosarcomas are slow-growing tumors that tend to remain localized. They contain a mixture of chondromatous and myxomatous elements and are only moderately sensitive to radiation. Under this form of therapy the rate of growth may be controlled in some patients over varying periods of time, and the associated pain may be definitely diminished or stopped. However, in other instances the tumor continues to grow slowly and progressively even under massive doses of surface radiation. In such cases it is best to resort to a combined surgical and radiation attack, as advocated by Handley. The bulk of the tumor is chiselled away and the entire operative field is implanted with platinum radium needles. Under such a régime, the growth is checked, but the treatment is followed by slow healing and multiple discharging sinuses that require prolonged dressings because of the exfoliation of cartilaginous and bony sequestra. Our records contain the histories of eight patients in this class, some of whom have had x-ray treatment alone, while in others there has been a combination of surgery and radiation. The accompanying Table II shows the results obtained.

Endothelial myeloma of Ewing is the most radio-

sensitive of all bone tumors, which is one of its diagnostic characteristics, as was mentioned earlier in the paper. It may disappear completely after irradiation, but in the majority of instances the effect is temporary; recurrence follows and distant metastasis is the rule. We have records of seven cases, two of whom passed the five-year period, but both patients died of the disease later. In all patients of the group there was histologic verification; the appended chart gives the end-results. (See Table III.)

Multiple myeloma is very sensitive to radiation and may be controlled for a limited period; however, the disease is so generalized that the possibility of cure is out of the question. We have not seen any case carry on longer than a year after the most carefully administered radiation.

Osteogenic sarcoma includes three varieties: sclerosing osteogenic sarcoma, osteolytic sarcoma, and periosteal fibrosarcoma. As a class, they are all extremely resistant to radiation. There may be temporary regressions, followed by marked relief from pain, but after a time growth increases and pain returns. Of the various groups mentioned, the periosteal fibrosarcoma seems to respond the best. A perusal of the literature indicates that there are cases treated by irradiation alone that have passed the five-year period. These must be looked upon as exceptions to the general rule, since the great percentage of cures obtained are by surgery alone or surgery combined with radiation. In our records we have four who have lived from 10 to 15 years after the diagnosis was made, all treated by surgery and radiation; none treated by radiation alone survived any great period of time. Table IV gives the details of all cases we have seen.

Hemangio-endothelioma of bone, blood vessel tumors of bones, have a varying degree of sensitivity, as do angiomas in other localities. Usually

TABLE III.—EWING'S TUMOR

Name Date	Sex Age	Region	Duration	Pathology	Operation	Recurrence	Metastasis Chest	Radiation	Symptom-free	Dead After
M. 1921	M. 24	Left femur	6 months	Sarcoma	Local excision	?	?	Radium, x-ray		3 years
A. 1923	M. 40	Left femur	2 months	Medullary sarcoma	Local excision twice	Yes	?	X-ray p.-o.*	Lost track of	
R. 1925	M. 34	Left femur	1 year	Ewing's	Amputation upper third of thigh after x-ray therapy	No	?	X-ray, H. V., 4 series over 3 years		10 years; no local recurrence
A. 1928	F. 24	Left os calcis	4 years	Small round-cell Ewing (?)	Exploration 4 years ago; curettage; refused amputation	Yes	Yes Lungs, late	X-ray elsewhere; radium inserted into cavity by us		8 years; chest metastasis
R. 1930	M. 36	Lower femur	4 years	Ewing's	Curetted out twice—first time in 1926	Yes	?	X-ray elsewhere, 2 series	Lost track of; examined but not treated by us; dead now	
P. 1930	F. 24	Left femur	?	Ewing's	Exploration; insertion of platinum radium needles	No	Yes	X-ray, H. V., 1 series		6 months
D. 1933	F. 11	Left ilium	7 months	Ewing's	Exploration for osteomyelitis	Yes	Yes Lungs	X-ray, 1 series; Coley's serum		6 months

* P.-o. = post-operative.

TABLE IV.—OSTEOGENIC SARCOMA

Name Date	Sex Age	Region	Duration	Pathology	Operation	Recurrence	Metastasis	Radiation	Symptom-free	Dead After
S. 1921	F. ?	Head right humerus	2 years	No	No	?	?	Radium		?
M. 1921	M. 13	Left femur	2 months	Sarcoma	Exploratory	No	No	Radium into wound; p.-o. x-ray*	15 years	
P. 1922	M. ?	Right upper humerus	6 weeks	No	No			X-ray		8 months
B. 1922	M. 15	Left femur lower third	4 months	Sarcoma	Exploratory and curettage; amputation	?	?	Radium into wound; x-ray pre- and post-op.		9 months
H. 1922	M. ?	Left ischium	2 years	Sarcoma	Exploratory	?	?	P.-o. x-ray	14 years	
K. 1922	M. 26	Right femur upper third	2 months	Sarcoma	Local excision and curettage twice	Yes	?	P.-o. x-ray	14 years	
M. 1922	F. 13	Left tibia	6 months	Sarcoma (low grade) on biopsy	Amputation, 1928. Found no malignancy in specimen	No	?	Three series x-ray over 3 years before amputation	1932; well 10 years†	
E. 1923	F. 13	Left scapula	2 months	Sarcoma	Exploratory	No	No	X-ray	Lost track of	
G. 1923	F. 14	Left occiput	?	Sarcoma	Local excision	Yes	Yes	P.-o. x-ray		2 months
M. 1923	M. 6	Right femur lower end	6 weeks	Osteosarcoma	Local excision and curettage	?	?	P.-o. x-ray		
L. 1924	M. 33	Coccyx	6 months	Sarcoma	Removal of tumor	?	?	P.-o. x-ray, 2 series		6 months
S. 1924	M. 40	Third rib right side	1 year	Sarcoma	Local excision twice	Yes	?	P.-o. x-ray		Yes
O. 1925	F. 50	Right pubic bone	1 and one-half years	No		?	?	X-ray		1 year
A. 1925	M. 45	Left femur upper third	4 months	No	No	?	?	X-ray		6 months
K. 1925	F. 56	Left humerus upper third	6 months	No	No	?	?	X-ray	Lost track of; probably dead	
G. 1925	M.	Right lower femur	1 year	No	No	?	?	X-ray	Lost track of	
McF. 1925	M. 35	Right upper humerus	1 year	No	No	No	No	X-ray, 1 series	Lost track of	
O. 1926	M. 45	Left femur	2 and one-half years	Periosteal sarcoma; autopsy	No	No	Yes Lungs	X-ray, 2 series; colloidal lead		9 months
R. 1926	M. 21	Left upper humerus	4 and one-half months	Sarcoma	Exploratory	Yes	Yes	X-ray, 1 series		8 months

A. 1926	M. 59	Right lower femur	10 months	No	No	No	Yes Groin	X-ray, 3 series		2 years
C. 1927	F. 7	Right tibia	3 weeks	Spindle-cell sarcoma	Exploratory	No	Yes Groin	X-ray, 1 series		6 months
W. 1927	M. 46	Right upper femur	?	No	No	No	No	X-ray, 1 series	Lost track of	
L. 1927	M. 56	Right ilium	4 years	Sarcoma	Exploratory	No	Yes Groin and neck	X-ray, 3 series		2 years
M. 1928	M. 31	Right mandible	7 years	Sarcoma	Exploratory and curettage 5 times	Yes	No	X-ray, radium	One and one-half years; lost track of	
L. 1929	F. 30	Left lower femur	2 years	Spindle-cell sarcoma	Exploratory and curettage	Yes	Yes Vulva	X-ray, 2 series; radium; Coley's serum		1 year
F. 1929	M. 33	Right side ilium	4 months	Periosteal sarcoma	Exploratory	Yes	Yes	X-ray, 2 series; lead; Coffey-Humber		6 months
R. 1930	M. 58	Left lower femur	6 months	No	No	No	Yes Groin	X-ray, 1 series		6 months
T. 1930	F. 60	Right lower femur	6 months	No	No	No	Yes Chest	X-ray, 1 series		6 months
S. 1930	M. 73	Right scapula	3 months	No	No	No	No	X-ray, 1 series		6 months
R. 1930	M. 15	Right lower femur	7 weeks	No	No	No	No	X-ray, 1 series	Lost track of; probably dead	
E. 1930	M. 14	Left lower femur	5 months	No	No	No	Yes Chest	X-ray, 1 series; Coley's serum		1 year
D. 1930	F. 33	Left parietal	6 months	Sarcoma	Exploratory	Yes	Yes Cheek	X-ray, 1 series	Lost track of	
L. 1931	F. 72	Left clavicle	4 months	No	No	No	No	X-ray, 1 series	1 year	1 year from heart attack
J. 1932	F. 33	Right upper femur	8 months	No	No	?	?	X-ray, 1 series	Lost track of	
S. 1934	M. 73	Left lower femur	4 years	No	No	No	Yes Inguinal nodes; chest	X-ray, 3 series for 2 years by others; 1 series, S. V., by us		6 months
L. 1934	M. 23	Left upper humerus	3 months	No	No	No	?			10 months
H. 1935	F. 14	Left lower tibia	2 months	Periosteal sarcoma	Exploratory	Yes	Yes Chest; groins	X-ray, 3 series		9 months
E. 1935	M. 60	Right lower femur	?	Osteogenic sarcoma	Exploratory	Yes	Yes Groins	X-ray, 2 series		1 year

* P.-o. = post-operative.

† On reviewing these slides, it is seen that this case is probably a benign tumor, possibly a giant-cell tumor.

TABLE V.—HEMANGIOMA OF BONE

Name Date	Sex Age	Region	Duration	Pathology	Operation	Recurrence	Metastasis	Radiation	Symptom-free	Dead After
W. 1928	F. 32	Twelfth dorsal vertebra	6 years	Hemangioma	Exploratory, 2 years ago	No	No	X-ray, 3 series	Yes; eight years since beginning	
W. 1931	F. 37	Head of left humerus	1 year	Hemangioma; aspiration biopsy verified at autopsy	No	No	Yes Skull	Three series: 1 H. V., 2 S. V.		Three years
D. 1932	M. 50	Right sup. maxilla	6 months	Hemangioma	Yes; electrocoagulation; complete destruction of right antrum	Yes	No	X-ray, radium		One and one-half yrs.; extension to brain

the younger the patient the more sensitive the tumor, but this alone is not a reliable point since these tumors may also have an abundance of endothelial elements that may or may not be sensitive. Our experience is limited to three cases. The initial response is very encouraging, but recurrence and metastasis is the rule. (See Table V.)

Metastatic bone tumors are secondary to growths arising in many organs. The thyroid, breast, prostate, and kidney harbor the primary tumor in the majority of instances; however, any organ may be the offender. Under irradiation such metastatic tumors may show complete regression and calcification. The relief from pain is striking and the individual may be restored to full activity, but eventually death comes from involvement of the lungs or liver. Every radiologist has records of such cases in his files. The case given below was reported by my colleague, Dr. Soiland.

Mrs. F., aged 40 years, came in with metastasis over the left chest and axilla following the radical removal of her left breast for carcinoma five years previously. The metastatic areas were subjected to intense x-radiation and in due course completely disappeared. One year after this treatment the patient developed pain, with restricted motion, in the left hip. She lost weight and became cachectic. Morphine was used and she was bedridden because of destructive metastasis in the left ilium and the sacrum. Under x-ray therapy the lesions disappeared, and within a month she was up, her pain had disappeared, and she had gained 30 pounds in weight. She considered herself well. Two years later she took a trip to Europe where, among other things, she climbed the Alps. She continued in good health for two years longer, then became bedridden with liver metastasis from which she died. This patient had her life prolonged three and one-half years, carrying on a normal existence and remaining well until a few weeks before her death.

Technic.—Radiation therapy of bone tumors has been going through an evolutionary phase, due to changes and improvements in apparatus. No two men have had the same idea as to the proper dosage, since some have used low voltage x-ray, some high voltage, some radium packs and bombs, and now we have the supervoltage x-ray. We have used all methods, and so far we have not seen any great or radical improvements in clinical results for the reason that tumors which are not sensitive to lower voltages have not been influenced to any greater extent by

supervoltages. With the extended use and application of the principles of Coutard's protracted method of irradiation, the question arises, "Will prolonged heavy irradiation give any better results?" With the possible exception of Ewing's tumor, we doubt that it will result in any increase in curability—certainly our experience in chondrosarcoma bears this out. Pain is diminished but growth is invariably slow and steady. However, we feel that it is too early to give a final opinion; furthermore, one must remember that prolonged heavy radiation may lead to radiation osteitis, a chronic disabling condition in itself. Likewise, it must not be forgotten that heavy treatment administered to the epiphyseal cartilages in the growing individual does result in atrophy and permanent deformity from destruction of the epiphyseal centers.

Should multiple ports be used as advocated by Desjardins? When apparatus was less powerful it was necessary to resort to such a method, but with higher voltages insuring greater dosages in the tumor itself, it seems to us that multiple ports are not now so necessary. Depending on the location of the tumor, especially if it is in an extremity, it is our usual procedure to give treatment through two or possibly three ports, using 200 kv., 4 ma. current, 50 cm. distance, 0.5 mm. Cu + 1 mm. Al filter, giving from 200 r to 300 r per port per day. To the giant-cell tumor we give a total of from 600 r to 800 r per port, after which the patient is not treated for three or four months, when a similar series may be repeated. In other words, we use moderate doses, repeat the series, and wait for the effects over a year or more. In the malignant bone tumors, a similar method of attack is used except that the filter is increased to 1 mm. Cu so that the dosage is increased up to from 1,200 r or 1,600 r per port, treating the patient daily. Even under this procedure the effect is usually only temporary. With supervoltages up to 500 kv. and a filter of 4 mm. brass and 0.5 mm. Pb, an equivalent of 13 mm. Cu, we have given up to 3,000 r per port, but even this may not control the growth in osteogenic sarcomas. Even in cases in which growth is controlled, metastasis has taken place that brought death to the patient.

In cases in which radium was used in the operative field, the technic has also changed. Fifteen years ago a 50 mgm. tube filtered through 1 mm. brass and 1 mm. rubber was packed in the wound. At present we have turned to highly filtered containers, using platinum needles containing 1 or 2 mgm. of radium with a filtration of 0.5 millimeter.

Discussion.—Giant-cell tumors many times are permanently cured by x-radiation. Surgery also cures these neoplasms. The question of the method to use must rest to a large extent with the patient. If he or she is willing to wait for radiation effects, then x-ray therapy may be advised. On the other hand, if for economic reasons the patient wishes a quick result, then surgery or cauterization is better. In cases in which one of the methods is followed by failure, resort can be had to the other.

In the report of the Registry of Bone Sarcoma sponsored by the American College of Surgeons, we find that they have records of 80 patients suffering from osteogenic sarcoma (including Ewing's tumor), who have passed the five-year period. Of these, 42 were cured by surgery alone, 35 by a combination of surgery and some form of irradiation with or without Coley's toxins, and three by radiation alone. While such a report is meager and does show progress in a condition formerly looked upon as hopeless, it gives only one side of the question. The number of patients not responding to any kind of treatment is omitted. The percentage of absolute cures must be relatively low. The nature of this tumor is such that metastasis often has taken place before the first consultation. Sometimes this metastasis shows up anywhere from a week to six weeks after the most carefully executed operation, so that the early appearance of metastasis is sometimes attributed to the manipulation incident to the operation it-

self. Whether or not such a theoretical question is true is difficult to answer, but possibly a change in technic may improve results. Though the rate of cure with radiation alone is low, this does not mean that many cells are not affected and that it should be abandoned. Disregarding the matter of professional and lay education and early diagnosis, whatever improvements take place must be along radiological and chemical lines, as surgery has reached its limit when amputation or curettage is resorted to. Few patients die of local recurrence; knowing this, and also knowing the extreme resistance of such tumors to radiation, would it not be justifiable to revise our attack? Give massive x-radiation over the tumor and along the shaft to the level of amputation, to the limit of tissue tolerance, or get radiation effects from the insertion of multiple platinum radium needles around the lesion before amputation. The latter method is used in infected massive epitheliomas of the tongue prior to removal by electrocoagulation, with recovery in some apparently hopeless cases.

What shall be done in cases in which the patient refuses amputation or when removal is not possible surgically? Granting that the pathologic diagnosis was correct, we have three patients still living on whom only an exploratory or a conservative local excision was done. In one, radium was used, and in the others post-operative x-ray. The surgery was really done to establish the diagnosis. In those patients in whom radium is used in the wound, the dosage must be gauged by the tissue examined. Here the same problem presents itself as in chondrosarcomas; a discharging sinus which requires prolonged dressings may result. In post-operative treatment with x-rays the dosage must be limited since a breaking down of the wound may result, and osteitis with fracture may take place. This is especially true in cases in which prolonged radiation may be attempted, but this must not be considered a contra-indication.

Summary.—Radiation therapy has a definite place in the treatment of bone tumors. In giant-cell tumors the results are good, while in some chondrosarcomas the results may be discouraging when used alone. The combined use of surgery and radium needles offers the patient a great deal for permanent cure. In osteogenic sarcomas and Ewing's tumor, radiation must be looked upon as an ancillary to surgery when cure is considered, but in the case of the inoperable patient and the one with metastasis, radiation is advisable to relieve pain and prolong life by growth control.

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THE GLIOMAS ROENTGENOLOGICALLY CONSIDERED

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IN order to be able intelligently to consider the gliomas from a roentgenologic viewpoint, we should first review briefly our present beliefs regarding the origin of these tumors and their development as pathologic entities. There are still differences of opinion as to the origin and classification of the gliomas, but it seems fairly safe to say that they originate from brain tissue which in some way has been stimulated to abnormal growth. There are many theories regarding the origin of gliomas which have been suggested from time to time by such well-known authorities as Cohnheim, Samuel, Monakow, Pfleger, Bailey, and others. Pfleger, as quoted by Bailey, has shown that in 75 out of 400 cerebellums that he studied he was able to find incompletely differentiated cells close to the roof of the fourth ventricle, which is a common site for the development of the medulloblastomas. This is a rather suggestive finding. Cohnheim's theory attempts to explain the origin of the gliomas from undifferentiated cells, but del Rio Hortega has shown that in many instances in which undifferentiated cells were thought to be present, actually the cells were quite well developed.

It seems highly probable that the origin of the gliomas is not essentially different from the origin of tumors elsewhere in the body, and that they arise from some "anlage" composed of cells capable of unrestricted growth when subjected to a suitable stimulus. If this is true, then we must conclude that these tumors are potentially present at birth in those persons who eventually develop such lesions. As a corollary to this assumption, we might be tempted to suggest radiotherapy for all, after the brain has become completely developed, in the hope that the tumor anlage is radiosensitive. We know brain tissue is extremely radioresistant so that such radiation would be harmless, and any harmless procedure which might reduce the prevalence of brain tumors would certainly be worth considering.

Many attempts have been made to classify the gliomas according to the cell types of which they are composed. Certainly one of the most successful of these efforts was that of Bailey and Cushing whose classification is, I believe, the most widely accepted of any to date. Briefly, their schema traces the development of the various tumors from the original medullary epithelium through the many cell differentiations, each giving potential origin to a particular type of tumor, and finally to the highly differentiated portions of the brain from which other types of tumors arise. This is well portrayed in Figure 1; from this chart it can be seen how the rather formidable nomenclature of the gliomas has been devised.

Before considering these tumors individually, it might be well to point out that brain tumors are by no means as uncommon as some are wont to believe. In fact they are exceeded in frequency only by tumors of the uterus, breast, and stomach, and the gliomas constitute about 45 per cent of intracranial newgrowths. Hence it would hardly be amiss to take this opportunity to urge that all cases of intractible headaches, including migraine, and certainly those showing impairment of function of any of the cranial nerves, be studied as possible cases of intracranial tumor, and given the benefit of a careful radiographic examination.

In searching for evidences of intracranial pathology one should bear in mind that poor films are a distinct liability. Technically poor films and those that are not stereoscopic will not only fail to show signifi-

cant changes but may give false evidence which is equally disconcerting. It has always been my conviction, and still is, that a history of the case, together, if possible, with the clinical findings, should be available if one is to properly evaluate the shadows on the film. This, of course, presupposes the practice of strict intellectual honesty.

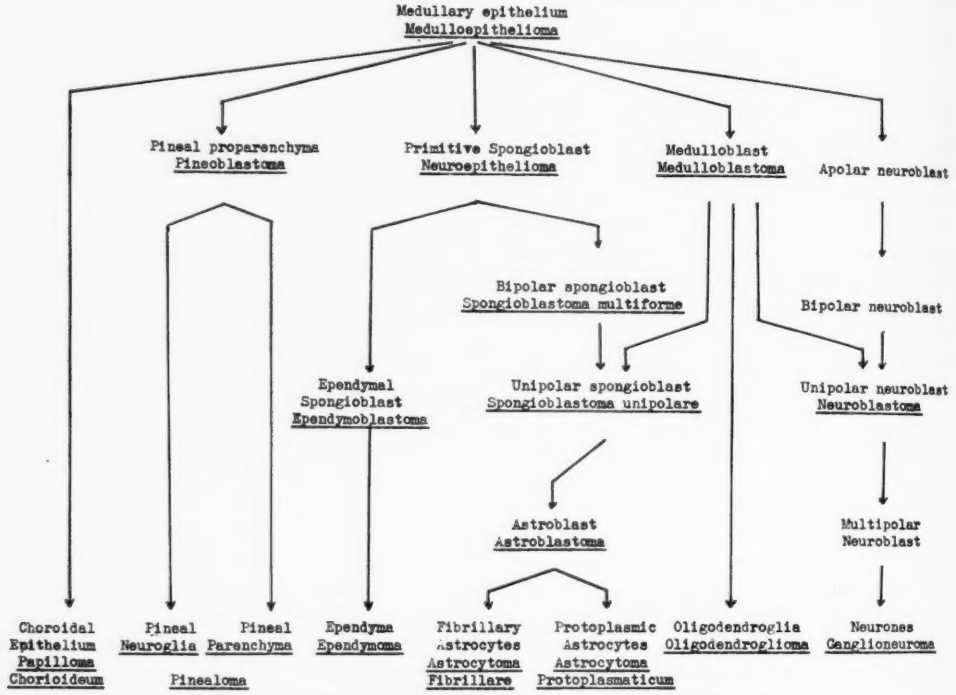

Fig. 1. From Bailey and Cushing, "Tumors of the Glioma Group."

Through the kind permission of Dr. Charles A. Elsberg, a search was made of the records of the Surgical Department of the Neurological Institute of New York covering the past ten years, and a group of several hundred cases, which were operatively proved gliomas and had had preoperative x-ray examinations, were collected and analyzed for this discussion. Dr. E. M. Deery, of the Surgical Department, was so kind as to allow me to study the descriptions of his recent microscopic findings regarding the effect of x-radiation on the gliomas. His conclusions are freely used in the evaluations to follow.

One of the most common of the gliomas is the glioblastoma multiforme or spongioblastoma multiforme, as it is often termed. It is a tumor of the adult cerebrum and at one time was called a gliosarcoma, but as sarcomas are not of glial origin this soon was recognized as a misnomer. These tumors formed about 30 per cent[1] of all gliomas. As the name "multiforme" implies, the tumors are composed of a multitude of cell forms, some poorly differentiated, which often makes the microscopic recognition of such a tumor difficult. It grows rapidly and infiltrates widely, even crossing at times to the opposite hemisphere through the corpus callosum. Hemorrhages are apt to occur within the growth and cystic degeneration is not uncommon. The tumor is often expansive, which trait when coupled with the usual surrounding

[1] These percentages are a composit taken from the reports of several neurosurgical clinics. This, I believe, gives a more accurate general average than would be obtained by quoting the averages from this clinic alone.

edema may produce a considerable elevation of intracranial pressure even though there be no definite block of the cerebral fluid pathways. The history of such a tumor is usually abrupt and malignant, and, practically speaking, operative interference is merely palliative. This is as might be expected because it is impossible in most cases macroscopically to determine where tumor-invaded tissue ends and normal cerebrum begins.

The glioblastoma multiforme is a rapidly growing tumor so that its course is usually too short to permit of much calcification taking place, but in many of these cases calcification is visible in the roentgenogram. The deposit is usually in the degenerated portion of the tumor, and although it has no characteristic configuration it is very apt to be amorphous, but the string-like and punctate forms also may be found. Due to the expansive characteristic of this form of glioma, the pineal gland is frequently displaced away from the lesion and signs of increased intracranial pressure may or may not be evident. Usually by the time an x-ray examination is considered advisable, the symptoms are rather well marked, so that evidence of intracranial disease may often be seen, such as atrophy of the dorsum sellæ and posterior clinoid processes. The recognition of atrophy of these structures depends chiefly upon the condition of the bony cortex, for it must be borne in mind that a hypocalcemia may produce a marked halisteresis of the bones of the base, but the cortex will be intact.

Briefly then, the recognition of the presence of a glioblastoma multiforme depends upon a short malignant history, the recognition of evidences of intracranial disease such as a displaced pineal gland, atrophy of the structures forming the sella turcica, and occasionally signs of generalized increased intracranial pressure with atrophy of the inner table of the calvarium, and a "fuzzy" deepening of the convolutional digitations. Calcification when present may be large or small in extent, and any shape, but it is likely to be amorphous.

Untreated, these tumors result fatally within about a year, and as a rule surgery offers but a few additional months. Radiotherapy is also disappointing, but with the application of from 2,500 to 4,000 r units in divided doses, the survival time may in some cases be boosted to as much as double that expected, with an occasional remission of symptoms so that the patient may regain a short period of usefulness. I feel convinced that the tumor cells are altered by x-radiation, and that evidently the so-called "law" of Bergonié and Trebondeau holds for the gliomas. We have still to determine the lethal dose for the various forms of brain tumors, and a study of the growth and metabolic characteristics of these tumors will be necessary before we can accurately predict whether the divided or massive dose technic will be the method of choice, and in fact determine whether the lethal dose for a glioma cell is really less than it is for normal glial tissue.

Fig. 2. Calcification in a glioblastoma multiforme. There are no signs of increased intracranial pressure which are so frequently lacking in presence of this type of glioma.

Another common type of glioma is the astrocytoma, which constitutes about 30 per cent of the glioma group. This form of tumor may be subdivided into the protoplasmic, fibrillary, and mixed varieties, but for the purpose of this discussion such a

Fig. 3

Fig. 4

Fig. 3. Astrocytoma of posterior frontal region. The change produced in the sella turcica is similar to the one produced by a pituitary adenoma.

Fig. 4. Astrocytoma of the temporal region. The calcification occurs in linear and punctate forms. The sella turcica shows but little evidence of atrophy.

divided classification will be unnecessary. The astrocytoma is a very slow growing tumor; in fact, it ranks as the slowest growing of all the gliomas, with the possible occasional exception of an oligodendroglioma. With relatively few exceptions, it is a tumor of the cerebrum of adults and the cerebellum of children. It might not be amiss to mention here that the majority of intracranial tumors of childhood occur below the tentorium.

This type of glioma is very apt to become cystic. This is especially true of those occurring below the tentorium, in which case the tumor may be found to be almost entirely cystic with only a small nubbin of tumor tissue attached to the cyst wall. The astrocytoma, like the glioblastoma multiforme, is an unencapsulated tumor, so that its exact extent in the surrounding brain tissue is difficult to determine at operation, but as the tumor is not at all vascular it can be attacked with considerable vigor, and not infrequently a complete removal will be possible. An astrocytoma occurring below the tentorium is most commonly found in one of the cerebellar hemispheres, although its origin occasionally may be traced to the vermis. Its site of election in the cerebrum is the temporal lobe; however, the frontal and parietal lobes are not immune. It is of interest to note that the occipital lobe is a relatively uncommon site for any brain tumor.

An astrocytoma will not infrequently contain sufficient calcium to cast a shadow in the roentgenogram. This tendency to calcify is, of course, to be expected, due to its slow growth and degenerative characteristics. The calcium deposit will not be found in any characteristic form, but it is more likely to be seen as linear streaks or as punctate deposits which must not be confused with the deposits of calcium so often seen in the glomus of the choroid plexus on one or both sides. Its location can, of course, be closely estimated from the study of stereoscopic films. When the tumor occurs below the tentorium in a child it is not likely to calcify, and the only roentgen evidence of its presence will be the results of elevated intracranial pressure such as separation of the sutures and deepening of the convolutional impressions, but usually without much evidence of atrophy of the sella turcica. When the lesion is above the tentorium we usually find, in addition to the calcification when that is present, considerable atrophy of the sella turcica and even, at times, ballooning of a

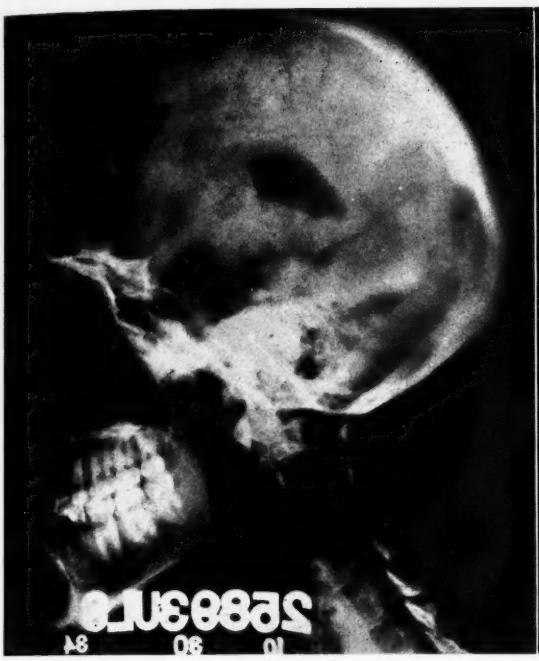

Fig. 5

Fig. 6

Fig. 5. Typical air study of a frontal lobe tumor. The frontal horns of the lateral ventricles are sharply cut off. Calcification can be seen in the frontal region which was in an astroblastoma.

Fig. 6. Same case as Figure 5. Anteroposterior view showing the shift of the lateral ventricles to the right, away from the site of the tumor.

type closely simulating that produced by a pituitary adenoma. There will also be present, if the tumor is large enough, general signs of increased pressure, such as atrophy of the inner table of the calvarium and deepened convolutional markings. If the pineal body is calcified it is very frequently displaced away from the site of the tumor. On very rare occasions a glioma may produce localized atrophy of the skull bones.

In summary, the roentgen diagnosis of an astrocytoma in a child depends upon a history of a few months of gradually progressive symptoms, signs of increased intracranial pressure, and little or no atrophy of the sella turcica. This, of course, is merely evidence of a tumor in the posterior fossa. In the adult we should have a history of many months, even years, of gradually progressing symptoms with perhaps remissions, signs of increased intracranial pressure, a shift of the pineal body, atrophy of the sella turcica which may be marked, and string-like or punctate deposits of calcium usually situated in the temporal lobe or in the temporo-fronto-parietal region.

The post-operative radiation treatment of the astrocytomas is to be advised, but empirically so. If the operation has been complete there is no reason to expect recurrence, and perhaps some of our apparently brilliant results from radiation are due chiefly to a brilliant and courageous operation; again, normal remissions in the growth of this type of tumor are not unknown. It should be noted here that occasionally an astrocytoma will take on the growth characteristics of a glioblastoma multiforme through an apparent cellular transition. Radiation might stop the tendency to such a metamorphosis; it evidently does something to these growths which slows their growth, so that even with

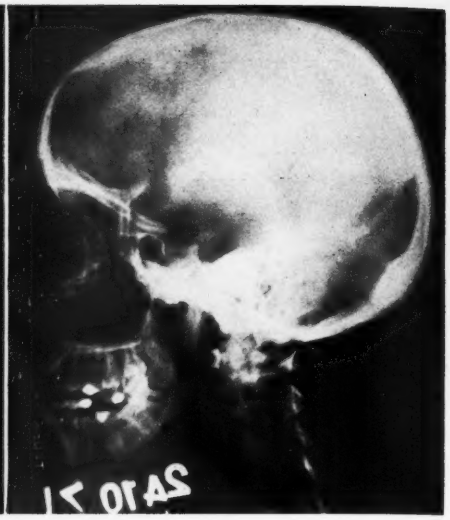

Fig. 7 Fig. 8

Fig. 7. Oligodendroglioma of the frontal region. The deposit of calcium is both linear and flocculent. The sella turcica shows marked evidences of destruction, which indicates that the tumor has been present for some time.

Fig. 8. Calcification in an intraventricular tumor, which was thought to be a papilloma both pre-operatively and at operation, but later pathologically diagnosed as an oligodendroglioma. Note the atrophy of the sella turcica but no other signs of increased intracranial pressure.

an operatively inaccessible tumor one should radiate vigorously. Due to the odd characteristics of growth of the astrocytoma, it is difficult to definitely evaluate any form of treatment, but apparently operation plus radiation may add many years to the patient's life.

The medulloblastoma is another common form of glioma but it possesses several unique characteristics. It was first adequately described by Bailey, and has since been found to constitute about 11 per cent of all gliomas. It is a tumor most frequently found in the posterior fossa of children of about nine to twelve years of age. The site of election for the medulloblastomas is close to, or involving, the roof of the fourth ventricle. These tumors are of rapid growth and have the unique tendency to spread widely through the leptomeninx, and cases have been seen in which they seem to have actually metastasized through the cerebrospinal fluid pathways. Such tumors may occasionally be found in young adults. Untreated, a patient with a medulloblastoma would not be expected to live more than about one year: often the course would be run in half that time. The tumor is rather vascular and solid, but due to its tendency to spread, its complete surgical removal is never successful.

The roentgen evidence of the presence of a medulloblastoma is usually the evidence of increased intracranial pressure only. Such a lesion rarely calcifies; in fact, so rarely that a deposit of calcium in the posterior fossa of a child should make one think, not of a medulloblastoma, but of an ependymoma or possibly an astrocytoma, a teratoid or a tuberculoma. The history will play an important part in making a differential diagnosis. The medulloblastoma will have a short malignant history which, of course, is not pathognomonic, but would at least be strongly suggestive.

The treatment of the medulloblastoma is rapidly becoming a non-surgical problem, provided a pre-operative diagnosis can be definitely made, because these tumors are remarkably sensitive to x-radiation. How-

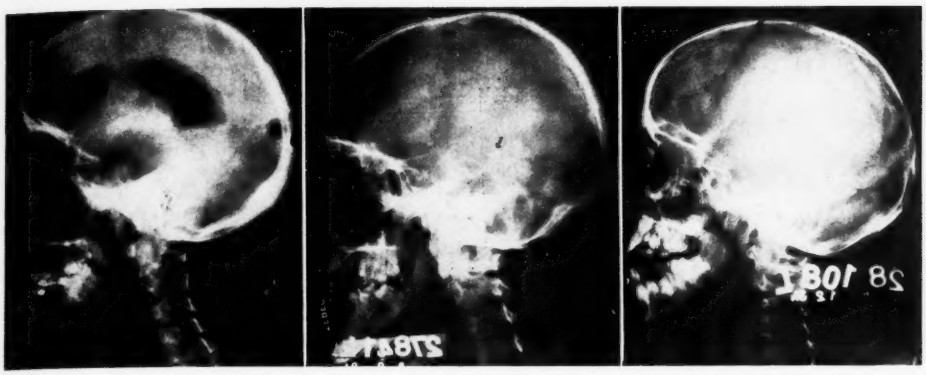

Fig. 9 (*left*). Some case as shown in Figure 8, after the injection of air, showing the enlargement of the ventricles and the filling defects due to the presence of tumor tissue.
Fig. 10 (*middle*). Small deposits of calcium can be seen which are in a spongioblastoma polare. The dorsum sellæ is slightly atrophic but otherwise there are no signs of an elevation of intracranial pressure.
Fig. 11 (*right*). The spotty deposits of calcium are in an ependymoma. Note the general signs of increased intracranial pressure.

ever, it is often advisable to operate first, merely making an occipital decompression, and, if possible, have a look at the tumor for purposes of diagnosis. An astrocytoma might produce identical symptoms, but if such a tumor were found it would, of course, be advisable to remove it immediately. Patients under intensive radiation therapy will often appear to have been completely cured as far as symptoms are concerned, and remain so over a period of years. The treatment had best be in divided doses because massive doses to the posterior fossa are apt to aggravate the symptoms by producing some edema, and also I am rather inclined to think that, especially in children, heavy radiation to the posterior fossa may give rise to a form of "radiation sickness" not entirely the result of edema. The treatment of this form of glioma should not be confined to the apparent location of the tumor but should include the entire head and spinal cord, because of its tendency to widespread dissemination.

The astroblastoma is a rather rare form of glioma which is found almost without exception in the cerebrum of adults. It is a tumor which is clinically quite similar to the glioblastoma multiforme, but constitutes only about 5 per cent of the glioma group. These tumors grow with a rapidity which permits a life expectancy of about two and a half to three years. Cystic degeneration is not uncommon but is much less common than in the glioblastoma multiforme. The tumors are not encapsulated and tend to invade surrounding brain tissue, so that at operation they are easily confused with the glioblastoma multiforme. The astroblastoma not infrequently calcifies. Histologically, the tumors are made up of embryonic astroblasts which tend to form themselves about blood vessels, and not infrequently the tumor will be found to contain spongioblasts and astrocytes, so that they are often classed as mixed tumors. The cells forming the astroblastomas occasionally contain mitotic figures.

To make a roentgenographic diagnosis of an astroblastoma would be practically impossible because these tumors are relatively uncommon, and, although they may calcify, the deposit is apt to be without distinguishing characteristics, and furthermore the history will strongly suggest a glioblastoma multiforme. There may or may not be evidences of increased intracranial pressure or a shift of the pineal gland. Air studies will be of no aid in a differential diagnosis but will merely show the presence of a tumor.

X-radiation would be expected to be of about the same efficiency in the treatment of an astroblastoma as it would be in the

treatment of a glioblastoma multiforme. The presence of mitotic figures in some of the astroblasts would, of course, suggest a moderate degree of radiosensitivity. The tumors should be treated because their complete surgical removal is rarely if ever accomplished. The treatment should be prolonged and vigorous.

The oligodendroglioma is a comparatively rare form of tumor constituting about 4 per cent of all the gliomas. It is a tumor found with but few exceptions in the cerebral hemispheres of adults of from forty to fifty years of age. This is rather odd when we consider the fact that the oligodendroglial cells are rapidly growing at and shortly after birth, but tumors do not develop until the cells are almost inert and practically homologous with the Schwann cells; however, they lose their propensities for rapid growth, for the oligodendroglioma is a very slow growing tumor, about on a par with the astrocytoma.

The tumors are solid, not apt to become cystic or degenerate, and although not encapsulated they are fairly well demarcated from the surrounding brain tissue. They are not very vascular and are rather prone to calcify. The calcification is usually found to be perivascular and, therefore, will appear in the roentgenogram as streaky or somewhat flocculent shadows. Operative success and survival periods for these tumors are quite comparable to those of the astrocytomas.

The recognition of an oligodendroglioma in the roentgenogram is usually very difficult because the changes seen and the history will be almost identical with the astrocytomas occurring in adults, and moreover as the astrocytoma is by far the more common tumor it is much more apt to be the correct diagnosis in any case of doubtful differentiation. However, if one sees a deposit of calcium which seems to be of a string-like type, probably following the course of blood vessels, which shows a flocculent, flaky configuration with or without pineal gland displacement or evidences of an elevation of intracranial pressure, in addition to a long, slowly progressive history perhaps covering years, one would be justified in making a highly probable diagnosis of an oligodendroglioma. It might be mentioned that in spite of the calcification being as a rule perivascular, it will not appear as double convoluted streaks such as are seen in the blood vessel anomalies.

Radiotherapy of these tumors is not as successful as might be expected, because there are very few cells which show mitotic figures, but, as in the case of the astrocytomas, it will slow the growth in case of incomplete surgical removal or inaccessibility. It is also a strongly advisable procedure because not infrequently when one of these gliomas recurs it does so in an altered and much more malignant and perhaps atavistic form.

The spongioblastoma polare is a tumor which occurs with about the same percentage frequency as the oligodendroglioma but it is very rarely found in patients much beyond the age of adolescence. It is very slow growing and has as its site of election the cerebral axis and brain stem. It is the most common form of glioma found involving the optic chiasm, and moreover, when found in this location it is frequently associated with von Recklinghausen's disease (neurofibromatosis). Occasionally one of these tumors will be found in the cerebellum of a child, and not infrequently one will be found in the pons, but in spite of the consequent enlargement of the pons the fourth ventricle will often not be compressed, so that there will be no increase of intracranial pressure. These tumors are solid, almost avascular, and usually show no cystic or degenerative changes, but they do occasionally contain deposits of calcium which can be seen in the roentgenogram. The recognition of the presence of a spongioblastoma polare in the roentgenogram is based upon several factors, depending upon the location of the lesion. If calcification were seen in a position close to the clivus and obviously in the pons with or without evidence of increased intracranial pressure, if the patient be young and the history long and slowly progressive, such a diagnosis would be highly probable. Calci-

fication near or about the clivus might be in a chordoma arising from the ecchordosis physaliphora, but such a tumor would be apt to have a more malignant and shorter history, and moreover, the chordoma is a rare tumor. The type of calcification is not characteristic.

Air injection studies in the presence of a tumor of the pons would be expected to show a posterior displacement of the fourth ventricle, which, of course, could be simulated by an aneurysm of the basilar artery, but the age of the patient would be against aneurysm as a diagnosis. On the other hand, a spongioblastoma polare of the optic chiasm would produce atrophy of the sella turcica which might involve the entire structure or, as is occasionally the case, the anterior clinoid processes would be chiefly involved with perhaps one showing the most atrophy. The optic canals often show enlargement and atrophy or destruction of the walls, with one, as a rule, showing the greater change. Rarely small deposits of calcium might be present in such a tumor which could be seen within the shadow of the enlarged optic canal. These tumors may extend far enough above the sella turcica to block the interventricular foramen, and so give rise to the signs of a general increase of intracranial pressure, with separation of the sutures and increased depth and number of the convolutional markings. Air studies not infrequently show a small filling defect or flattening of the cisterna chiasmatis. These changes in a child or young adult with or without neurofibromatosis would be strongly presumptive evidence of the presence of this type of glioma. Meningeal tumors might simulate these changes but the age of the patient would practically exclude such a possibility. Bucconeural pouch tumors should also be considered in a differential diagnosis, but they do not produce changes in the optic canals and they are apt to show calcification above or at the side of the sella turcica.

Radiotherapy is often the only form of treatment possible for a spongioblastoma polare, because its location usually makes it surgically inaccessible. X-radiation would not be expected to be of much value in treating such a slowly growing tumor, which contains as few mitotic figures as this type of glioma does. In fact, with our present technic about all we can hope for is a slowing of the growth, but this does seem to be possible, so that perhaps a year or more may be added to the life expectancy of the patient.

The ependymomas constitute another group of tumors which are but little less common than the two types previously discussed. They form about 3 per cent of the glioma group. These tumors are of ependymal origin and occur in two forms, the ependymoma and the ependymoblastoma, which can not be differentiated in the roentgenogram. They occur along the ventricular walls with a predilection for the fourth ventricle. The tumor is comparatively benign and were it not for its unfavorable location one might be present for years without giving rise to more than minor symptoms, but a tumor of or in the fourth ventricle soon becomes a menace to life and calls for vigorous action. The ependymomas often occur in children and not infrequently calcify sufficiently to cast a shadow in the roentgenogram. It might be of interest to mention that this form of tumor is among the most frequently found in the spinal cord.

The roentgen diagnosis of an ependymoma is dependent upon the finding of evidences of increased intracranial pressure with or without atrophy of the sella turcica, usually without. The patient is almost invariably a child. Calcification, if present, will usually be found as a small flocculent amorphous deposit near the midline in the posterior fossa or possibly near the position occupied by the lateral ventricles. As calcification in the pineal gland of a child is uncommon, the displacement of this structure will rarely be a factor in making the diagnosis, so that without calcification we merely have the evidences of increased intracranial pressure which would not permit of making a differential diagnosis. Air studies are often of great value in the location of these tumors which, of course, can

be readily outlined if they project into one of the ventricles. Ependymomas are often confused macroscopically with the medulloblastomas. Radiotherapy offers but little in the treatment of an ependymoma; operation should be resorted to as soon as a diagnosis can be established as to its location. Then intensive radiation would be advisable in the hope of forestalling a recurrence which is unfortunately not uncommon.

Tumors of the pineal body are relatively rare, less than 2 per cent of all gliomas, and may be histologically divided into several groups which cannot be differentiated preoperatively. The tumors occur at any age but are more common in children, associated with precocious sexual development. Due to their position directly above the aqueduct of Sylvius, the patient usually succumbs within a comparatively short time as a result of the rapid increase of intracranial pressure. In spite of the frequent tendency of the pineal gland to calcify, tumors of this structure rarely contain calcium.

The roentgen diagnosis of a pineal tumor is usually very difficult, if not impossible, without air studies. The history of a precocious child with signs of increased intracranial pressure would be strongly suggestive. If calcification be present, its position and size would be strongly confirmative evidence. Air studies would in the majority of cases have to be done by ventricular puncture, and would probably show a bilateral ventricular dilatation with a probable defect in the posterior portion of a large third ventricle.

The surgical attack on a pineal tumor is extremely difficult and often impossible, so that the survival time for such a case is usually but a few months from the onset of pressure symptoms. Radiotherapy has little to offer these cases, as there is danger from intensive radiation of increasing the symptoms by producing some edema and more complete blocking of the aqueduct of Sylvius; therefore, it would be advisable to surgically drain the ventricles before instituting radiation therapy. The best that can be offered at present in favor of radiotherapy is that it probably will slow the growth of the tumor, but so few of these tumors are available for any form of therapy that as yet our ideas regarding such possibilities are largely empirical.

A relatively rare form of tumor is the papilloma of the choroid plexus: it constitutes less than 1 per cent of all gliomas. These papillomas are rarely encountered in patients over ten years of age and their site of election is the fourth ventricle. They do not, however, entirely shun the lateral ventricles, and even the third ventricle may contain a choroidal papilloma, but this is extremely rare and may at times prove to be an extension from one of the neighboring ventricles. When such a tumor arises in the fourth ventricle it may extend through the foramen of Luschka and give rise to the signs of a lateralized cerebellar tumor. These tumors may at times become partly cystic and show degenerative tendencies. Although the choroidal papilloma is usually included in any discussion of the gliomas, it is of interest to note that it does not contain any true glial tissue.

The papilloma itself is comparatively benign, but its location is unfavorable and usually leads to a block of the cerebral fluid pathways and a consequent rise of intracranial tension. This is not always true of these growths, for one may be present without giving rise to any definite symptoms for a long time as the tumor grows very slowly. Occasionally such a tumor calcifies and so reveals its presence in the roentgenogram. If this calcification be in a large tumor, it may be possible to visualize practically the entire extent of a ventricle.

The diagnosis of a choroidal papilloma in the roentgenogram would, as a rule, be almost impossible without air studies. When such a tumor occurs in the fourth ventricle of a child it would be expected to give only the signs of a posterior fossa tumor, which are merely those of increased intracranial pressure. It rarely calcifies in a child. The history is vague unless the blockage occurs suddenly; headache as a

rule is the predominant symptom. When such a tumor occurs in an adult the diagnosis would depend upon finding a streaky or punctate deposit of calcium in the position usually occupied by one of the ventricles, with or without signs of increased intracranial pressure. One should be on guard against confusing the shadow cast by calcification in a large glomus of the choroid plexus with a papilloma, although at times such a differentiation may present difficulties. In a large percentage of benign choroidal calcifications they will be seen to be bilateral, which is against their being in a papilloma, but, of course, papillomas have been found simultaneously in both lateral ventricles. Air studies will usually permit the outlining of these tumors when they occur in an adult, but such a tumor in the fourth ventricle of a child might well defy all our pre-operative diagnostic methods to make a differential diagnosis.

Radiotherapy is to be recommended on theoretical and practical grounds. The tumors are, of course, vascular, and x-radiation has been known evidently to reduce the vascularity and hence the rate of growth. The cytoplasm of the papilloma contains mitochondria, and as these minute but evidently important cell structures are highly radiosensitive we would expect radiotherapy to have a definite degenerative influence on the cells containing them.

There are several other forms of gliomas, as can be seen from a study of the chart of Figure 1, but they are rare and one would have little hope of being able to make a pre-operative diagnosis. Their manifestations in the roentgenogram would not differ in any distinguishable manner from the more common forms which have already been discussed, and in fact to which they are, as may be seen from the chart, directly related.

In any large group of gliomas there will be a fairly sizable proportion which will have to be grouped as unclassified and mixed tumors. These complicate considerably the making of definite pre-operative and sometimes post-operative diagnoses, because they may simulate at times any of the better defined types. For this discussion, the group of mixed tumors and those diagnosed by the finding of cystic fluid only were eliminated.

If one has had the fortitude to read this article thus far, it must have become evident that the pre-operative roentgen diagnosis of the various glioma types is wellnigh impossible; unfortunately it often is, and we have to be content with a diagnosis of "brain tumor, probably a glioma." But as time goes on and more and more of these cases are studied with the ability to correlate history, clinical findings, and roentgen findings, an accurate pre-operative differential diagnosis becomes less and less uncommon.

It may be of interest to mention briefly some statistics bearing upon the group of tumors gathered together for this discussion, in spite of the fact that statistics may often be more misleading than enlightening. In the group of astrocytomas, 16 per cent were calcified sufficiently to cast a shadow on the film, and 70 per cent gave definite roentgen evidence of the presence of intracranial pathology. The cases with glioblastoma multiforme showed that 11 per cent were calcified, whereas 50 per cent showed evidences of pathology. Seventy per cent of the astroblastomas gave evidence of pathology in the roentgenogram, and 40 per cent calcified sufficiently to make localization possible. Eighty per cent of the medulloblastomas gave roentgen evidences of intracranial disease but only 3 per cent contained calcium; this consisted of one case in which there is still some doubt as to its being a pure medulloblastoma. Eighty per cent of the oligodendrogliomas were calcified and the same percentage gave evidence of pathology. The papillomas, a small group, showed that 60 per cent were calcified, and 100 per cent showed evidences of disease. Twenty-five per cent of the ependymomas were calcified and 100 per cent showed evidences of disease. Thirty-three per cent of the group of spongioblastoma polares contained calcium, and 70 per cent showed evidences of pathology.

These percentages are high, chiefly because all the cases comprising this group had symptoms sufficiently well marked to justify operative interference, which, of course, means that in each instance the tumor had progressed well beyond the incipient stage. In practically 100 per cent of those having air studies, positive localizing findings were obtained. The only exceptions were those whose ventricles did not fill sufficiently well to permit of an adequate visualization.

The problem of the why and wherefore of tumor calcification might be briefly discussed here; it is still unsolved. A few years ago it was thought that if we could encourage intratumoral calcification we might be able to add to our ability to make accurate localizations. This problem was discussed with Dr. Walter Timme, who suggested trying large doses of calcium and vitamin D. This was tried on several cases of known tumors undergoing radiotherapy, but nothing definite occurred. Such a test is, of course, neither fair nor convincing because undoubtedly the tumor metabolism is altered by the radiation. We have seen cases increase their calcium deposit while undergoing x-radiation on a normal diet and without any evident change in the blood chemistry. A further study of this problem might be very interesting.

The problem of radiation therapy of brain tumors and the gliomas in particular is still unsolved. Deery is apparently able to show cell changes after radiation in these growths; others have been unable to convince themselves of the possibility of such changes. I am inclined to believe that x-radiation can profoundly influence the cell activity of brain tumors, and that we should by no means abandon this method of attack until we have carried out more experiments and made a greater effort to discover what radiation really is capable of accomplishing.

We know that glutathione, which is a peptide-like chemical and is found in all tissues, is reduced in amount by radiation; we also believe that this substance stimulates mitosis. Therefore, it may well be that it is the reduction of the glutathione in the tissues that reduces tumor growth, and we know that as a rule growth is reduced in proportion to the mitotic figures present. If this be true, small repeated doses would be indicated in order to keep growth quiescent or at a minimum for a long period of time so that the tumor cells may become senile and degenerate, both due to the reduction of the concentration of glutathione and the effect on the mitochondria which seems to have something to do with cell respiration. I doubt whether a massive attack on the tumor cells is the method of choice, because probably the tumor cells are but little less resistant to such an attack than the surrounding brain tissue. Nature has a tendency to compensate for the loss of any necessary substance, so that probably in time glutathione is produced in sufficient quantities to overcome the effects of radiation. This may explain the ultimate growth of Hodgkin's lymphogranulomas after being inhibited for a time by radiotherapy; the same with the medulloblastomas. Therefore, the problem may well be to modify the radiation according to the amount of glutathione present and keep its concentration at a minimum.

If, as seems likely, radiotherapy is not only a physical problem but also a definitely chemical one, then it is likely that the chemical change will be optimal at a certain temperature. If this could be determined for the gliomas and also for brain tissue, it would be conceivably possible to maintain this temperature of optimal activity by diathermy or short wave radiations, provided the temperature was found to be not too high for the tissues to withstand, and so make our radiotherapeutic efforts much more efficient.

SUMMARY

An attempt has been made to discuss the gliomas from the viewpoint of the roentgenologist, and to point out how in some cases pre-operative differential diagnoses may be made in the presence of the better differentiated and more common forms of

these tumors, and also to add a brief discussion of the rationale of radiotherapy.

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A STUDY OF THE EFFECT OF SKULL ROTATION ON ROENTGENOLOGICAL MEASUREMENTS OF THE PINEAL GLAND[1]

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SPACIAL orientation of the pineal has received the attention of recent investigators with particular reference to its importance in localizing masses within the cranium. Schuller (4), in 1918, was probably the first to correlate the calcification of the pineal with the lateralization of a mass. "One can also, for example, in case of displacement of the shadow of the pineal gland to the right or left of the median line in symmetrically formed skulls, conclude the cause of its displacement to be pressure on the part of the tumor or traction on the part of a brain scar."

It was not for some time, however, that routine work was done in relating the position of the pineal to intracranial masses. Naffziger (3) appears to have been the first to carry out Schuller's suggestion in a series of brain tumors. His observations concerning pineal displacement were limited strictly to those of the anteroposterior films, attempting only the lateralization of the lesion. "The degree of the pineal shift, as we have termed it, varies considerably. A common shift is a distance of about one centimeter. We have, however, found it displaced away from the lesion for a distance of 2.5 to 3.0 centimeters." He believed that its value was limited to those cases which showed increased intracranial pressure. A midline position of the pineal under such conditions of pressure indicated an infratentorial position of the mass. This writer indicated that he contemplated at some time in the future the working out of a method of determining the position of the pineal on the lateral film which would permit the identification of displacement in the other two planes of space. It remained, however, for Vastine and Kinney (5) to work out such a method. Briefly, this method may be described in the following manner.

The greatest anteroposterior diameter of the skull was obtained, *i.e.*, from the inner table of the frontal region at its most distant point from the pineal to a similar point at the occiput. They found that in normal cases there was a definite range for the position of the pineal along this line, and that in many of their tumor series there was displacement anteriorly or posteriorly in regard to this zone. Similarly, a vertical diameter was obtained by selecting the most distant point at the inner table of the vertex of the skull to the floor of the posterior fossa, and a normal range for the position of the pineal was determined. The range for normally located pineals for skulls of varying size is best shown by means of their graphs. While the normal cases generally fall within this zone, many of the cases of brain tumor showed displacement either above, below, in front of, or behind this normal zone.

Dyke (2), in 1930, corroborated the value of this method in dealing with a very large series (nearly 2,000 cases). He called attention to the fact that some normal cases fell outside of the normal zone as established by Vastine and Kinney, the number being less than 14 per cent. The exact error in the method is difficult to determine owing to the fact that tumor suspects and tumor cases which were unverified were included in the series.

None of these writers discuss the effect of

[1] This question arose in discussions with Dr. W. P. Van Wagenen, whose helpful co-operation has lent much valuable aid in making this study.

rotation of the skull upon these measurements except to indicate that rotation should be avoided. Dyke states: "It is quite essential to have anteroposterior or postero-anterior films exactly straight in order to be sure of the pineal shadow. Minor degrees of rotation on the lateral film are of less importance in the measurements, but for accurate measurements the film should show the floors of both anterior fossæ superimposed and the descending rami of each jaw also superimposed on each other."

Davis (1), in analyzing the value of pineal orientation in the diagnosis of tumors of the brain, writes: "Naturally it is all-important to have roentgenograms which are taken accurately to be able to detect a small shift in position of the calcified gland. Stereoscopic lateral roentgenograms of the skull make it possible to identify small changes in the position of the gland quite readily. Sosman uses a pelvimeter fitted with earpieces and a long pointer. The earpieces are placed in the patient's ears and the head is rotated so that the pointer is directed straight upward at the target of the tube. Naffziger employs a similar device, with the earpieces of a stethoscope to insure a proper accurate position. Often a postero-anterior roentgenogram will show the position of the calcified pineal quite clearly . . . . We have found the pineal shift to be a very valuable aid in the lateralization of a supratentorial lesion. Its corroborative value in frontal lobe tumors with few clinical symptoms is great. We have not been able to use it as a diagnostic aid in localizing a tumor in any particular lobe of the brain, but as a lateralizing sign its aid cannot be questioned."

In our routine work the question has frequently arisen concerning the value of the result obtained in cases in which either the anteroposterior or the lateral film showed a slight degree of rotation. In many cases of brain tumor the anteroposterior film would show the pineal on measurement to lie lateral to the mid-sagittal plane of the skull as determined by the midpoint between the inner tables of the sides of the skull. Often no conclusions were drawn because of the fact that the head was somewhat rotated. Such rotation is highly undesirable and, being aware of the caution urged by the previous investigators, we were commonly tempted to discount our results if the head showed any rotation. However, in doing so we frequently wondered if slight degrees of rotation might not be permissible without destroying the evidence of a pineal which was grossly displaced. If any degree of rotation was permissible, we were interested in finding out what this extent might be without

TABLE I.—EFFECT OF HEAD ROTATION ON PINEAL MEASUREMENTS

	Pineal in Normal Position									
	Measurements of Anteroposterior (AP) Film						Measurements of Lateral Film of Skull			
Position	Deg. of Rotating	Max. Trans. Diam. Skull	Rt. Side of Calv. to Pineal	L. Side of Calv. to Pineal	Front Marker to Pineal	Back Marker to Pineal	Type of Rotation	Deg. of Rotating	Frontal Bone to Pineal	Max. AP Diam. of Skull
AP	0°	15.5	7.8	7.7	0	0	Rotating face downward	0°	10.3	18.0
	2°	15.5	7.8	7.7	0.3	0.3		4°	10.2	18.0
	4°	15.5	7.7	7.8	1.0	0.7		8°	10.1	17.9
	6°	15.5	7.8	7.7	1.5	1.1		12°	10.0	17.8
	8°	15.4	7.8	7.6	1.7	1.3		20°	9.7	17.4
	10°	15.4	7.6	7.8	2.5	1.6	Rotating occiput downward	4°	10.1	17.9
	15°	15.5	7.7	7.8	3.9	2.4		8°	10.2	18.0
								12°	10.1	17.9
								20°	10.2	17.9

vitiating results. We started this investigation feeling very certain that any considerable degree of rotation would throw of the calvarium in place (target-film distance, 30 inches).

The results of this preliminary test

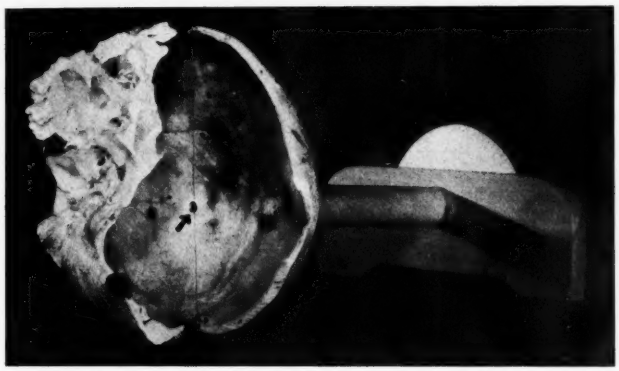

Fig. 1. Radiopaque pineal oriented within cranium of dried skull showing manner of maintaining position of the skull during the exposure. The round shaft which rotates within the collar of the standard and a protractor scale furnished a suitable means of changing the degree of rotation at will.

our measurements vastly off, but we did wish to find out if a minor degree really invalidated the measurements.

Our curiosity led us to set up a skull of normal shape (linear index 84), with a pineal of lead properly oriented according to Vastine and Kinney measurements (Fig. 1). The skull was 16 cm. in length with a biparietal diameter of 15.5 centimeters. It was fastened to a support as shown in the illustration, with a protractor scale to indicate the degree of rotation employed. Having obtained a film free of rotation, the head was then turned through increasing degrees of rotation. For the first test the skull was placed in the antero-posterior position.

Markers were placed at the mid-line on the forehead and the occiput to give us additional information concerning the change in relationships between the position of the pineal and these two markers. These markers, which were opaque, were of different shapes to distinguish them from one another and also from the pineal gland. Two, 4, 6, 8, 10, and 15 degrees of rotation were used, in each case obtaining a radiograph with the pineal and opaque markers (Table I), which were somewhat of a surprise to us, yielded the following data. Without rotation, the pineal fell at the mid-sagittal plane as would be expected. The measurements from the pineal to either side of the skull (inner table) were 7.8 cm. and 7.7 centimeters. The total transverse width of the skull was the sum of these two, or 15.5 centimeters. As will be observed these measurements are within 1 mm. when the center of the pineal is employed as the measuring point. With two degress of rotation the transverse diameter remained unchanged and the measurements concerning the midposition of the pineal likewise remained unaltered. The pineal did not shift to one side of the mid-line provided the midpoint along the maximum transverse diameter was taken as the criterion. It should be noted, however, that, due to their location in regard to the center of rotation, the opaque markers on the front and back of the head were separated from the pineal, the anterior one falling to one side of the pineal and the posterior one to the other. Using four and six degrees of rotation, the pineal still fell at the mid-point between the most distant

points of the inner table. As the rotation increased the opaque markers on the front and back portions of the head showed more separation from the pineal, the anterior one showing the greater amount due to the fact that the latter was farther from the film. At 8, 10, and 15 degrees there was relatively little difference in the transverse diameter of the skull. This did not exceed 1 mm., which represented an error possibly due to measurement alone rather than to any actual change in the transverse diameter. At 15 degrees the experiment was stopped because the extent of the rotation was so excessive that it would exceed any amount of rotation which would ever be encountered, even under poor conditions of technic.

The observation is striking that, regardless of any ordinary amount of rotation,

TABLE II.—EFFECT OF HEAD ROTATION ON PINEAL MEASUREMENTS

			Pineal Displaced 1 cm. to Right of Mid-line Anteropostero and Postero-anterior Measurements				Measurements of Lateral Film			
Position	Deg. of Rotation	Max. Trans. Diam.	Rt. Side Calv. to Pineal	L. Side Calv. to Pineal	Front Marker to Pineal	Back Marker to Pineal				
Anteroposterior rotating rt. face downward	0°	15.4	6.5	8.9	1.4 R	1.2 R	Rt. lateral rotating rt. face downward	0°	10.4	17.9
	2°	15.4	6.5	8.9	1.4 R	1.0 R		4°	10.3	17.8
	4°	15.4	6.5	8.9	0.3 R	1.8 R		8°	10.5	17.9
	6°	15.3	6.5	8.8	0.0	2.0 R		12°	10.5	17.9
	8°	15.1	6.5	8.6	0.9 L	2.4 R		20°	10.4	17.8
	10°	15.2	6.5	8.7	1.5 L	2.7 R				
	15°	15.2	6.6	8.6	2.8 L	3.3 R	Rotating rt. occiput downward	4°	10.4	17.9
								8°	10.4	17.8
Rotating left face downward	0°	15.6	6.5	9.1	1.8 R	1.1 R		12°	10.3	17.8
	4°	15.6	6.5	9.1	2.4 R	0.8 R		20°	10.0	17.8
	8°	15.5	6.4	9.1	3.3 R	0.3 R				
	12°	15.6	6.5	9.1	4.0 R	0.0	Left lateral rotating left face downward	4°	10.4	17.9
	20°	15.7	6.4	9.3	5.8 R	1.0 L		8°	10.3	17.9
								12°	10.2	17.9
Postero-anterior rotating left occiput downward	0°	15.9	6.6	9.3	1.3 R	1.3 R		20°	10.2	17.9
	4°	15.9	6.7	9.2	1.1 R	1.8 R				
							Rotating left occiput downward	4°	10.5	17.9
	8°	16.1	6.8	9.3	0.2 R	2.5 R		8°	10.7	17.8
	12°	16.1	6.8	9.3	0.5 L	3.1 R		12°	10.7	17.7
	20°	16.1	6.9	9.2	1.7 L	4.4 R				
Rotating rt. occiput downward	4°	16.2	6.7	9.5	2.1 R	0.8 R				
	8°	16.2	6.7	9.5	2.9 R	0.0				
	12°	16.2	6.7	9.5	3.4 R	0.4 L				
	20°	16.1	6.7	9.4	4.2 R	1.4 L				

neither the maximum transverse diameter of the skull nor the position of the pineal along this maximum transverse diameter changes. The anterior and posterior markers, as would be expected, showed increasing separation from one another and from the pineal as rotation occurs. It is important to recognize the advantage of using the maximum transverse diameter of the skull in determining lateral displacement rather than any points at the brow or occiput.

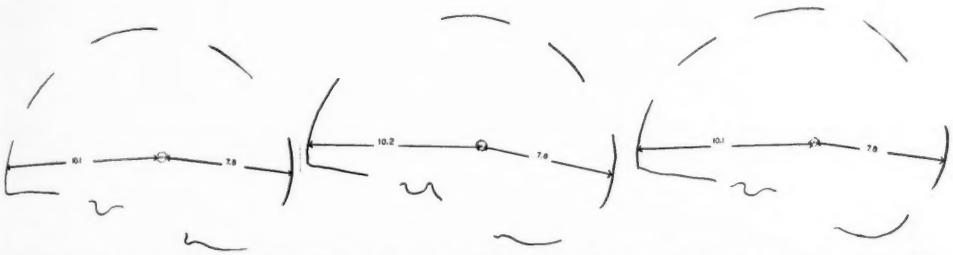

Fig. 2. Tracings of lateral films of experimental skull films, (1) without rotation, (2) 8° rotation, (3) 12° rotation. The measurements do not change appreciably until 12° has been exceeded.

Experiments were also carried out employing the postero-anterior rather than the anteroposterior position to determine if reversing the position of the head would alter results. This was found to have no appreciable effect. Lateral films were next obtained, turning the head 4, 8, 12, and 20 degrees. No change in the anteroposterior diameter of the skull exceeding 2 mm. occurred until 12 degrees of rotation were employed. The anteroposterior diameter of the skull and the distance from the frontal bone to the pineal likewise changed very little. It will be noted that with the extent of rotation employed in these experiments, the position of the pineal is not materially altered along the maximum anteroposterior diameter of the skull (Table I). Such rotation as is apt to occur in routine work does not invalidate the results if the pineal is in normal position.

It next became important to learn if a displaced pineal would be recognized in the presence of rotation. Similar experimental conditions of the skull were employed, in which the pineal was displaced laterally, anteriorly, posteriorly, superiorly, and inferiorly, to determine if displacement in these two planes of space could still be identified. Table II lists the results when the pineal was displaced 1 cm. to the right of the mid-line. Independent of the position employed in securing films (whether the brow or occiput was down against the film) and the direction of the rotation, the position of the pineal remained essentially unchanged, provided measurement was taken along the plane of the maximum transverse diameter. The distances between the front and back markers and the pineal changed constantly with the degree of rotation. It is obvious that a pineal displaced to the right of the mid-line will appear to the right of both the front and back markers of the skull in unrotated skulls. If rotation occurs, the degree of separation between the marker and the pineal will vary according to the direction in which the head is turned, and as rotation increases the distance between one of the two markers and the pineal will decrease until they are superimposed and finally the pineal will be observed to be on the opposite side of this marker as the rotation becomes extreme. The placing of markers at the mid-line over the forehead and over the occiput does not appear to be desirable, therefore, for the identification of pineal displacement. On the other hand, one has a very easy method of determining pineal displacement by locating the midpoint of the maximum transverse diameter of the skull, and determining displacement

directly by this method. The position of a pineal interpreted in this manner, independent of any rotation which may be present, will be correctly placed, *i.e.*, a pineal which is to the right of the mid-sagittal plane of the skull will appear to the right of the midpoint of the maximum transverse diameter of the skull whether rotation is present or absent.

Similar tests were carried out, employing the lateral position of the skull. Films obtained with the pineal in normal position (Table I) show no appreciable alteration of the position of the pineal when either the face or occiput is rotated downward toward the film through 4, 8, and 12 degrees. The changes in the anteroposterior diameter of the skull are likewise unimportant, until the rotation exceeds 12 degrees (Fig. 2). Even when the left lateral aspect of the skull is placed against the film, with a pineal displaced 1 cm. to the right of the mid-sagittal plane (Table II), rotation of the head produces no significant changes.

The displacement thus far discussed pertains entirely to lateral displacement of the pineal from the mid-sagittal plane of the skull. Other experiments were carried out, however, orienting the pineal 1 cm. anterior to its normal position, obtaining films with 4, 8, 12, and 20 degrees of rotation, alternately rotating the face and the occiput downward. The data shown in Table III indicate that it is impossible by means of rotation such as may occur in routine radiography to make a pineal which is either anterior or posterior to its normal position to appear within the normal zone or to reverse the direction of its displacement. A pineal which is anterior to its normal position will continue to appear in this position, independent of rotation of the skull. Over 12 degress of rotation are necessary before there is any appreciable change, either in the anteroposterior diameter of the skull or in the measurements of the pineal gland.

When the pineal was displaced upward or

TABLE III.—EFFECT OF HEAD ROTATION IN PINEAL MEASUREMENTS (LATERAL SKULL FILMS)

Pineal Displaced Forward 1 cm.				Pineal Displaced Downward 1 cm.			
Position	Degree of Rotation	Frontal Bone to Pineal	Maximum Antero-posterior Diameter	Position	Degree of Rotation	Vault to Pineal	Vertical Diameter of Skull
Rotating rt. face downward	0°	9.4	17.7	Rotating base downward	0°	8.5	13.5
	4°	9.4	17.7		4°	8.5	13.6
	8°	9.4	17.7		8°	8.5	13.7
	12°	9.4	17.8		12°	8.5	14.0
	20°	9.3	17.5		20°	8.3	14.2
Rotating occiput downward	4°	9.4	17.7	Rotating vault downward	4°	8.6	13.7
	8°	9.4	17.5		8°	8.5	13.6
	12°	9.3	17.3		12°	8.5	13.5
	20°	9.4	16.9		20°	8.5	13.7
Pineal Displaced Backward 1 cm.				Pineal Displaced Upward 1 cm.			
Rotating rt. face downward	0°	11.1	17.7	Rotating vault downward	0°	7.9	13.8
	4°	11.2	17.8		4°	7.9	13.8
	8°	11.2	17.9		8°	7.9	13.9
	12°	11.2	17.8		12°	7.9	13.9
	20°	10.9	17.7		20°	7.9	14.1
Rotating occiput downward	4°	11.1	17.7	Rotating base downward	4°	8.0	13.9
	8°	11.0	17.5		8°	8.1	14.1
	12°	11.0	17.6		12°	8.2	14.0
	20°	10.9	16.7		20°	8.5	14.1

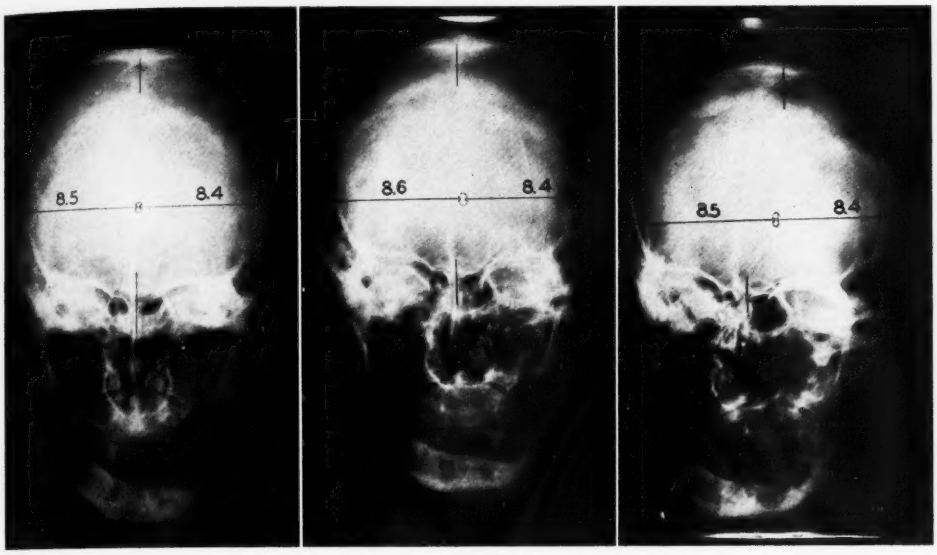

Fig. 3. Anteroposterior films of normal adult male, showing effect of rotation of the head. The pineal was densely calcified and could be readily identified regardless of the degree of rotation. The radiograph at the left shows the skull without rotation, the middle one with a slight degree of rotation, and the one on the right with marked rotation. The distances from the pineal to either side of the skull do not vary more than 2 mm. (normal variation), regardless of the degree of rotation.

downward along the vertical axis of the skull it was important to determine if rotation of the skull, turning the base or the vault downward toward the film, would change the measurements materially. Our tests indicate that while some slight changes occur in the vertical diameter of the skull, these changes are not of material consequence until 12 degrees of rotation are obtained. We are forced, therefore, to the conclusion that the pineal, which is displaced to one side of the midsagittal plane of the skull or displaced to the anterior, posterior, upward, or downward, will continue to show similar displacement of approximately the same degree of magnitude even when the direction of rotation is a favorable one to possibly alter the relationships. In general, we may say that 12 degrees of rotation and in many instances more than this are necessary before any definite change occurs and even when such changes become apparent its degree is of such slight magnitude that it would not mislead one in misinterpreting its position.

In interpreting anteroposterior or pos-

TABLE IV.—PINEAL MEASUREMENTS OBTAINED FROM ROUTINE ANTEROPOSTERIOR AND POSTERO-ANTERIOR FILMS OF NORMAL SKULLS SHOWING NO ROTATION

Case	Max. Trans. Diam.	Midpoint of Trans. Diam.	Inner Table to Pineal	
			R	L
1	15.9	8.0	7.9	8.0
2	17.0	8.5	8.5	8.5
3	16.8	8.4	8.5	8.3
4	16.1	8.1	8.1	8.0
5	16.7	8.4	8.3	8.4
6	18.0	9.0	9.0	9.0
7	16.7	8.4	8.5	8.2
8	17.4	8.7	8.8	8.6
9	16.4	8.2	8.1	8.3
10	16.1	8.1	8.0	8.1
11	16.6	8.3	8.3	8.3
12	16.8	8.4	8.5	8.3
13	16.2	8.1	8.1	8.1
14	16.6	8.3	8.3	8.3
15	16.5	8.3	8.2	8.3
16	16.0	8.0	8.0	8.0
17	17.4	8.7	8.8	8.6
18	17.6	8.8	8.8	8.8
19	18.0	9.0	8.9	9.1
20	17.2	8.6	8.5	8.7
21	17.6	8.8	8.8	8.8
22	17.8	8.9	9.0	8.8

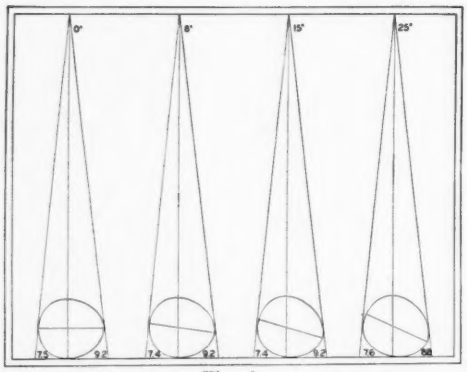

Fig. 4.

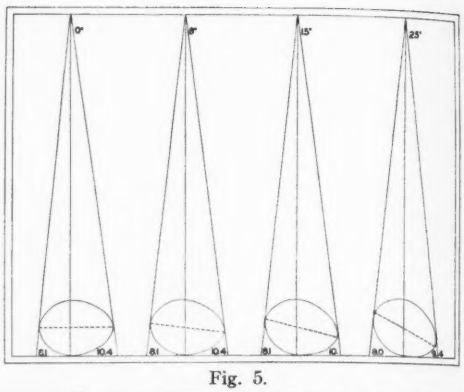

Fig. 5.

Fig. 4. Effect of head rotation upon pineal measurements (brachycephalic skull with linear index 0.87). No appreciable change in measurements is noted until the rotation is in excess of 15°.

Fig. 5. Effect of head rotation upon pineal measurements (dolichocephalic skull with linear index 0.71). No change is evident in the pineal measurements until 8° is exceeded. Even at 15° the percentile change is small.

TABLE V.—PINEAL MEASUREMENTS OBTAINED FROM ROUTINE ANTEROPOSTERIOR AND POSTERO-ANTERIOR FILMS OF NORMAL SKULLS SHOWING ROTATION

Case	Max. Trans. Diam.	Mid-point Trans. Diam.	Inner Table to Pineal		Extent of Rotation
			R	L	
1	16.6	8.3	8.4	8.2	Considerably turned
2	17.5	8.8	8.8	8.7	Slightly turned
3	17.0	8.5	8.5	8.5	Slightly turned
4	16.2	8.1	8.1	8.1	Slightly turned
5	17.3	8.7	8.7	8.6	Slightly turned
6	16.9	8.5	8.4	8.5	Slightly turned
7	16.4	8.2	8.2	8.2	Slightly turned
8	17.2	8.6	8.5	8.7	Considerably turned
9	16.8	8.4	8.4	8.4	Considerably turned
10	17.6	8.8	8.7	8.9	Slightly turned
11	16.2	8.1	8.2	8.0	Slightly turned
12	18.1	9.1	9.0	9.1	Slightly turned
13	17.2	8.6	8.6	8.5	Slightly turned
14	16.8	8.4	8.4	8.4	Considerably turned
15	18.2	9.1	9.2	9.0	Slightly turned
16	17.2	8.6	8.6	8.6	Slightly turned
17	16.8	8.4	8.4	8.4	Considerably turned
18	17.3	8.7	8.7	8.6	Slightly turned
19	16.7	8.4	8.5	8.2	Considerably turned
20	15.9	8.0	7.9	8.0	Slightly turned

tero-anterior films no displacement of the pineal should be considered unless the difference between the measurements obtained between the pineal and the two sides of the skull exceeds 2 millimeters. Such precautions are found not only necessary in practical work but this would appear desirable from a theoretical standpoint since one cannot assume that the center point of calcification always represents the center of the pineal and furthermore it is unsafe to assume that the two sides of the cranium are strictly bilaterally symmetrical. We have found from experience that variations of 2 mm. or less should be considered normal.

To illustrate the effect of rotation in actual clinical work the skull films of a patient are shown in Figure 3. This individual was selected because on examination he showed a very opaque pineal and because there was no history suggestive of any space-occupying mass within the brain. The first film was obtained without any rotation of the skull; the pineal was found to be 8.5 cm. from the right side of the calvarium and 8.4 cm. from the left side. The head was then intentionally turned to a slight degree and measurements of 8.6 and 8.4 cm., respectively, were obtained. The head was finally turned to an extreme degree, in fact, to an extent that would not be permitted in routine radiography of the skull. Even with a high degree of turn, the pineal oriented itself very close to the midpoint along the transverse diameter, *i.e.*, 8.5 cm. from the right side of the calvarium and 8.4 cm. from the left. The 1 mm. of difference obtained in the course of

the turning should not be considered significant. In reviewing some of our recent skull radiographs we set aside all those apparently normal cases showing calcified pineals on either the anteroposterior or postero-anterior films. These were divided into two groups (Tables IV and V), those in which no rotation of the head was present and, secondly, a group in which some degree of rotation was present. The amount was in most cases of a slight degree, though in six out of 20 cases the amount of rotation was considerable. In no case, however, did the degree of rotation approach that observed in the experimental dried skull. A series of 22 normal cases without any rotation showed a maximum difference of 2 mm. in the measurements between the sides of the skull and the pineal. In a series of 20 skulls in which rotation was present, 2 mm. likewise was the maximum difference in the measurements on the two sides. It would appear quite safe, therefore, to assume that differences of 2 mm. should not be interpreted as due to pineal displacement and, secondly that, regardless of any slight degree of rotation which may be present, no allowance need be made for rotation.

The rationale underlying these relationships is best explained by means of mechanical diagrams. Figure 4 shows the effects of rotation of a brachycephalic skull on the projected pineal measurements of the film. It will be noted that in this skull at least 15 degrees of rotation are required before the projected measurements are altered. Figure 5 shows a similar result with a dolichocephalic skull. The effect of rotation is more pronounced in a skull with a long anteroposterior diameter, but, in spite of this effect, over 10 degrees of rotation are required before materially affecting results. Even at 15 degrees the proportional relationships of the pineal vary only 1 per cent from those obtained in the true lateral position.

CONCLUSIONS

1. A study of the effect of rotation of the head upon pineal orientation has been made employing the anteroposterior, postero-anterior, and lateral positions of the skull.

2. A pineal located in normal position will not appear displaced on the anteroposterior or postero-anterior film even in the presence of rotation of the head such as might occur in routine radiography, provided the midpoint of the maximum transverse diameter of the skull is accepted as the criterion to determine the displacement.

3. A pineal displaced laterally will be correctly interpreted as to direction and extent of displacement in the presence of rotation if this same criterion is employed.

4. Measurements of the lateral film indicate that those showing rotation not exceeding 12 degrees may be interpreted and the position of the pineal may be determined directly by the usual measurements without making any allowance for the rotation.

5. These findings have proven to be reliable for pineals which have been displaced along either of the two planes of space relating to the lateral film, *i.e.*, along the anteroposterior or vertical diameters of the skull.

6. In determining lateral displacement of the pineal by means of the anteroposterior or postero-anterior films an allowance of 2 mm. in making measurements on either side of the midpoint of the maximum transverse diameter of the skull has been found desirable in routine work to allow for slight mechanical errors which arise in making measurements and minor variations in skull symmetry.

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PROBLEMS IN RADIATION THERAPY[1]

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PART I.—PRODUCTION OF X-RAYS

BEGINNING with the terminals of the switch-box and ending with the x-ray target, an attempt will be made to give important intervening steps in the production of x-rays.

X-ray Tubes.—An x-ray tube is a glass envelope, or bulb, containing a filament and anode sealed into the glass and so placed that the filament is opposite the anode. In order to produce x-ray tubes which will withstand the bombardment of a target with fast moving electrons, all metallic parts before being sealed into the x-ray tube must be treated with heat in a vacuum furnace. The x-ray tube, containing all parts sealed into the bulb, is then placed in a furnace and the bulb sealed to a vacuum pumping system. The temperature of the furnace is increased and maintained at a point just below the temperature at which glass begins to soften. The temperature is maintained for a matter of hours in order to liberate the occluded gases of the glass walls. The terminals of the x-ray tube are connected to a high voltage energizing unit, and as the voltage is increased on the target, the gases liberated by the hot filament, the target and any occluded gases from the walls of the x-ray tube are pumped out of the bulb. This process is kept up, gradually increasing the voltage on the target, until there is no more gas liberated after prolonged operation at voltages and milliampere currents greater than the ratings of the x-ray tube.

Cathode.—The size of the focal spot is governed by the diameter and shape of the spiral filament and also the relative position of these with respect to the target. In a fine focus tube, the filament is placed farther back in the focussing cylinder.

The focus of x-ray tubes designed for therapy have been made divergent by Coolidge in projecting a molybdenum pin through the center of the filament.

The line focus with an anode face at 20 degrees instead of the conventional 45 degrees, makes possible an x-ray tube of greater capacity with the retention of the fine definition of a smaller round focus tube.

Metal disks about the filament are intended to intercept stray electrons from striking the glass.

Choice of Anode.—Less than 1 per cent of the kinetic energy ($\frac{1}{2}$ mv^2) is consumed in producing x-rays by the impact of electrons at the face of the target of an x-ray tube, and more than 99 per cent of the kinetic energy goes into heat. The capacity of an x-ray tube depends upon the dissipation of heat from the target. A fine focus x-ray tube will not have as high rating as to voltage and milliampere current as a broad focus tube. In a fine focus tube, the heat is concentrated over a smaller area of the target than in a broad focus tube. An increase of voltage will cause a greater quantity of heat to be developed in the target because the velocity of the electrons is increased. As the milliampere current is increased, a greater number of electrons strike the target, hence more heat is developed.

The choice of anode depends upon: (1) *metal of high atomic weight,* because the quality of x-rays from a target is a function of the atomic weight; (2) *metal of high melting point* so that the target may withstand the greatest amount of heat and therefore insure a higher capacity x-ray tube; (3) *metal of high thermal conductivity* so that the heat that is generated will be dissipated as quickly as possible and therefore insure a greater capacity x-ray tube; (4)

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metal of low vapor pressure at high temperatures so that the anode will not volatilize and deposit a coating of metal on the bowl of the x-ray tube (*tungsten*, *tantalum*, and *platinum* possess these properties, tungsten being superior).

Transformers.—The essential parts of a high voltage transformer consists of two separate coils of wire wound around a soft iron core. One coil of a comparatively small number of turns of wire of rather large diameter is connected to the incoming voltage and is called the primary; the other coil, consisting of a large number of turns of rather fine wire, is called the secondary. In such a transformer, the voltage is transformed from low to high, and at the same time the current changes from high through the primary to small through the secondary. In a filament transformer, in which the incoming voltage is reduced, the primary coil has a greater number of turns compared to the secondary coil.

If an alternating current is sent through the primary coil and the secondary coil makes a closed circuit, a current will be generated in the secondary coil. The current in the secondary coil is an *induced current* from the current in the primary coil. Since the current in the primary coil is changing its direction 120 times a second, in a 60-cycle alternating current source, the magnetic field of force which always surrounds a wire carrying a current and perpendicular to the wire, also changes in magnitude. In an alternating current, the current rises from zero to a maximum, dropping to zero in $^1/_{120}$ part of a second: in the next $^1/_{120}$ part of a second the current reverses its direction, again starting at zero current, rising to a maximum, and then back to zero, making a complete circuit in $^1/_{60}$ of a second. Since the magnetic field of force, generated in the primary coil, changes in magnitude in the same manner as the alternating current, an alternating current of the same type is induced in the secondary coil. Therefore, a changing magnetic field of force is responsible for induced currents.

Where it is necessary to have a direct current source, a motor generator can be used to produce an alternating current, and with an alternating current source, the voltage can be transformed. Since an induced current can be produced in the secondary coil of a transformer because of a changing magnetic field of force, anything that might interrupt a direct current connected to the primary of the transformer would also interrupt the magnetic field of force, causing a change in magnitude from a maximum to zero. If the current can be interrupted many times a second, then a workable induced current can be generated in the secondary coil. Interrupters have been and are still used to interrupt direct current sources in order to obtain a changing magnetic field.

A moving magnetic field from a magnet will induce a current in a coil of wire. This can be demonstrated by moving a magnet inside a coil of wire connected to a galvanometer. Every movement of the magnet will be indicated by a reading of the galvanometer. If the north pole of a magnet be thrust downward in the coil, the reading on the galvanometer may be to the right, and if the magnet is pulled upward out of the coil, the reading of the galvanometer will be to the left. It is seen, therefore, that any *changing magnetic field of force* about the secondary of a transformer will induce an alternating current in the secondary coil.

The voltage produced in the secondary coil compared to the voltage in the primary coil is approximately proportional to the number of turns of wire of the secondary to the number of turns of the primary coil. It is, therefore, possible to have a transformer increase the primary voltage, as happens in the high voltage transformers for producing a voltage on the target of the x-ray tube, and in a low voltage transformer for reducing the voltage to be applied to the filament of the x-ray tube.

The secondary coil of the high voltage transformer is usually grounded half-way between the terminals. Approximately half of the total voltage between the terminals of the transformer is above and half

below ground potential. This method of construction requires less oil insulation and hence a smaller container for high voltage transformers.

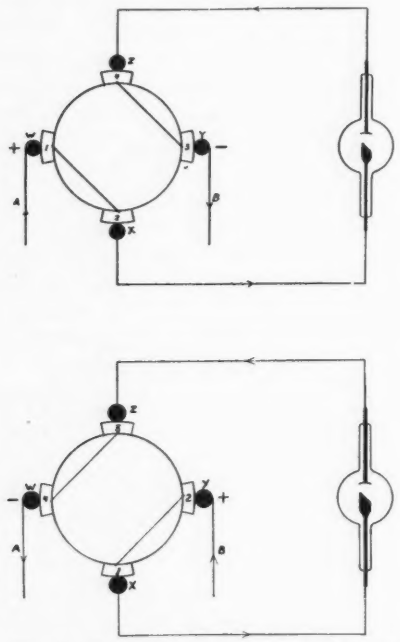

Fig. 1. Part 1 (*above*), Part 2 (*below*), Mechanical Rectification.

Controls.—A control unit consists of an auto-transformer and resistance for the purpose of varying the voltage reaching the terminals of the high voltage transformer. A meter registers the voltage variation and is sometimes called a potential indicator, which enables the operator to determine how constant the primary voltage is maintained while the x-ray machine is operating. By maintaining a constant primary voltage, the operator is insured of a constant high voltage, excluding leakages due to poor insulation, etc., in the high voltage circuit.

The filament control varies the voltage applied to the primary of the filament transformer and, in turn, controls the temperature of the filament.

In mechanically rectified x-ray machines, a polarity meter indicates whether or not the positive phase of the rectified current is applied to the target of the x-ray tube.

Rectification.—The high voltage alternating current leaving the terminals of a high voltage transformer is connected directly to the terminals of an x-ray tube, the target becoming alternately positive and negative every $^1/_{120}$ part of a second. This is the arrangement employed with self-rectifying units such as portable units, or high voltage units whereby two tubes are operated from the terminals of the same transformer.

The current can be rectified mechanically by rotating insulating disks, toroids, or cross-arms operating on a shaft connected to a synchronous motor which operates in synchronism with the phase changes of the alternating current. There are four collecting brushes, or shoes, on the insulated rectifiers; brushes one and two are connected together with an electrical conductor, and brushes three and four are connected together with an electrical conductor. The brushes are set in such a manner as to collect the crest of the alternating wave. The crest of the negative phase is changed in direction so that a positive potential is always applied to the target of the x-ray tube. In one revolution of a rectifying disk, four alternating wave crests are conducted to the target of the x-ray tube. Since there are 120 alternations per second of a 60-cycle alternating current, there are 7,200 alternations per minute. If the rectifying disk picks off the crest of four alternations in one revolution, the synchronous motor must make 1,800 revolutions per minute. The polarity meter indicates to the operator whether the high voltage connection to the target of the x-ray tube is conducting the positive or negative phase.

Figure 1 diagrammatically illustrates mechanical rectification of an alternating current cycle. In Part 1, *A* and *B* are conductors from the terminals of the high voltage transformer. If the direction of the alternating current is passing upward through conductor A and No. 1 brush of the rotating disk is opposite *W*, the termi-

nal of conductor A, current will pass across the junction to No. 1; from No. 1 to No. 2 brush through a conductor, across to X manner, the target intermittingly carries a positive charge of electricity. The disk, toroids, or cross-arms are so set on the

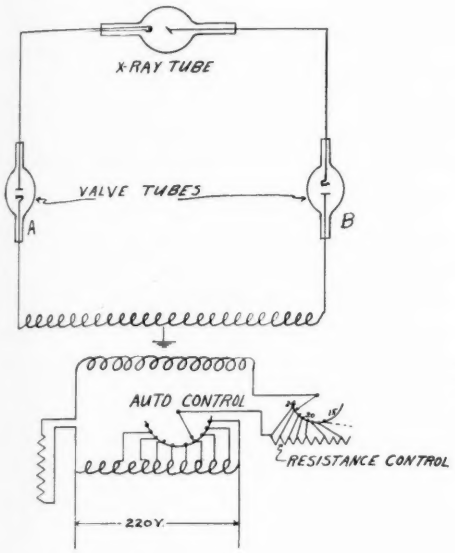

Fig. 2

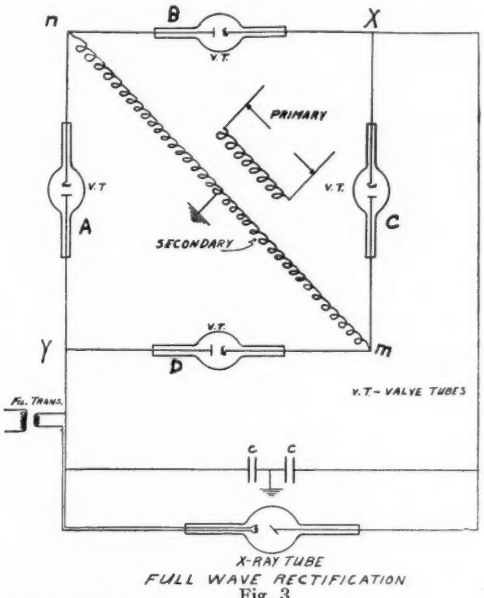

Fig. 3

Fig. 2. Half wave rectification.
Fig. 3. Full wave rectification and constant potential.

through to the target of the x-ray tube. The attraction of the electrons from the filament to the target conducts the current across to the filament, to Z, across the space to No. 4 brush, through the conductor to brush No. 3, across to Y and back to the transformer by way of conductor B. While the alternating current is changing in direction, the rectifying disk has made $^1/_4$ of a revolution, placing brush No. 1 in the position of brush No. 2 in reference to terminal X, which is connected to the target. Brushes 2, 3, and 4 have also advanced $^1/_4$ of a revolution, as will be shown in Part 2. Due to the change in the direction, the alternating current is passing upward through transformer conductor B, across to brush No. 2, through a conductor to brush No. 1, across to X, to the target and filament of the x-ray tube and to the terminal Z; across to brush No. 3, through the conductor to brush No. 4, across to W, the terminal of the transformer. In this shaft of the synchronous motor that each peak of the alternating current half-cycle is conducted to the target.

There is an interval of time during which brush No. 1, passing from W to X, is not conducting current from either W or X. The rectifying disk is so arranged on the shaft of the synchronous motor that during the interval when there is no current being conducted, the voltage has passed the positive peak, through zero and on the way to the negative peak. Brush No. 2 begins to conduct current from Y before the negative peak is reached. This arrangement insures maximum peak voltage rectification and maximum output of radiation.

Valve Tube Rectification: Half-wave.— With half-wave rectification, two valves are used and are connected into the high voltage circuit in such a manner that only a positive potential can reach the target. Only the positive phase of the alternating current is used in the production of x-rays;

the negative phase is submerged. The milliampere current is usually a little more than double the current observed on the milliampere meter, due to the fact that every $^1/_{120}$ part of a second there is no current passing through the x-ray tube, the milliampere meter reading being an average.

Figure 2 illustrates half-wave rectification of high voltage alternating current by two valve tubes. If the half-cycle of the alternating current is passing through conductor toward valve *B*, the plate of valve *B* is charged positively. Electrons, generated at the filament of valve *B*, are attracted to the plate and current will pass through the valve and on to the target of the x-ray tube through the filament and on to the plate of valve *A*, to the filament of valve *A*, thereby making a complete circuit through the high voltage transformer. As the alternating current changes in direction, the current passes up to valve *A*. Since the electrons are generated by the filament and since the filament is now positive, no electrons can pass across the filament to the plate. Hence, this half-cycle of the alternating current is submerged.

Full Wave Valve Tube Rectification.—Four valve tubes are connected in the high voltage circuit in such a manner that the target is positive during both phases of the alternating current. The voltage rises from approximately zero to peak voltage and back to zero again. The average, or effective voltage is considerably lower than the measure of the peak voltage as measured with sphere gaps.

Figure 3 illustrates full wave rectification. If the direction of the alternating current cycle is toward high voltage transformer terminal *m*, the current cannot pass through valve *D* because the filament is positively charged so no current can pass through the valve tube. The current can pass through valve tube *C* because the plate is positively charged, attracting the electrons from the filament and thereby conducting the current from the plate to the filament. At *X*, the current cannot go through valve *B* because the filament has a positive charge. The current can, however, go in the opposite direction through the conductor to the target of the x-ray tube, to the filament and to *Y*. Here the current will not pass through valve *D* even though the plate carries a positive charge, because this would not conduct the current to the other terminal, *n*, of the transformer, thereby completing the circuit through the transformer. The current can pass through valve *A* because the plate carries a positive charge, on through the filament to *n*, making a complete circuit. The next half-cycle, *n*, is the positive terminal of the transformer. The current cannot pass through valve *A* because the filament acquires a positive charge. The current can pass through valve *B* because the plate becomes positive, the current being conducted to the filament by electrons and to *X*. The current cannot pass through valve *C* because the filament has a positive charge but can pass to the target of the x-ray tube, through the x-ray tube to *Y*. Again the current in order to reach *m* will not pass through valve *A* even though the plate is positively charged, but will go through valve *D*, because the plate takes on a positive charge, to the filament carried by electrons and to *m*, again making a complete circuit through the secondary of the high voltage transformer.

Therefore, it is seen that in a four-valve tube rectification, the target carries a positive charge all through the alternating current cycle. It is true, however, that the positive voltage will rise from zero to a peak, back to zero, repeating the same 120 times per second.

Figure 3 also illustrates a method of employing condensers in a constant potential x-ray machine. It is seen that with four-valve tube rectification, the voltage is an average from zero voltage to a maximum, or peak voltage. If the voltage is measured by a sphere gap, a reading of the peak voltage will be obtained. This, of course, is higher than the effective voltage for the reason just given.

Constant Potential.—The effective voltage can be made to more nearly approach

peak voltage by the addition of condensers, which are shown as *CC* in Figure 3, and are connected across the high voltage line in parallel with the x-ray tube. When the target of the x-ray tube receives the maximum voltage, the condensers are also charged to the same maximum voltage. While the voltage of the alternating current cycle passes from a maximum through zero and back to a maximum, the condensers tend to maintain the maximum voltage on the target of the x-ray tube. The voltage will, of course, decrease somewhat. The voltage drop in the condensers will depend upon the size of the condensers, or the quantity of electricity they can hold and the milliampere current passing through the x-ray tube. The voltage drop is called "ripple" of the condensers.

X-rays.—The different methods of applying a voltage to the target of an x-ray tube have been described. Assuming a positive potential on the target, the mechanics of the production of x-rays is as follows: negative electrons are evaporated from the heated filament of the x-ray tube, the number per second varying with the temperature of the wire which, in turn, varies with the current passing through the wire. An increase in the current through the filament by the filament control increases the number of electrons and, hence, increases the x-ray intensity.

Since negative electrons carry a negative electrical charge, these electrons when evaporated from the filament will be attracted to the target if there is a positive charge of electricity on the target. This fact is explained by the mutual attraction of unlike electrical charges and the repulsion of like charges.

Kinetic energy is developed at the time of impact of the electron with the face of the target. The formula for kinetic energy is $^1/_2\ mv^2$, where m is the mass of the electron and v the velocity of the electron. The mass of the electron is constant, consequently the only variable in the formula for kinetic energy is the velocity. Therefore, in order to increase the kinetic energy, or the energy of impact on the face of the target, it is necessary to increase the voltage applied to the target.

As a rule, the electron will not be arrested instantaneously at the face of the target, but will penetrate a few layers of tungsten atoms and will be arrested in its path in a more or less gradual manner. In most instances, the velocity and accompanying energy are reduced by successive stages. Considerably less than 1 per cent of the kinetic energy of an electron goes into producing x-rays, while more than 99 per cent of the energy goes into heat. The electron does not necessarily continue in a straight line after striking the face of the target, but the electron may change its direction after each absorption change in its velocity. The final direction of the electron may be sufficiently changed so that it again emerges from the target. Other electrons leave the surface of the target, such as orbital electrons of the tungsten atoms expelled by the bombardment of the fast moving filament electrons under the influence of the positive charge of the target. Still other electrons, called "Compton electrons," may be liberated by the x-rays produced. All of these stray electrons are called "secondary electrons" and may cause trouble in the life and construction of x-ray tubes.

If all of the electrons could be instantaneously stopped at the face of the target, a large proportion of the kinetic energy of the electrons would go into the production of x-rays. Since a large proportion of the electrons are stopped by a slowing-down process, a very large percentage of the kinetic energy developed at the face of the target goes into heat. Since such a large percentage of the kinetic energy develops heat and such a small percentage x-rays, it becomes a serious problem for x-ray tube manufacturers to devise means of dissipating the heat. Some x-ray tubes have the tungsten target in the form of a button embedded in copper, because copper is a better conductor of heat. Radiating surfaces are attached to the outside of the copper stem in order to insure greater loss of heat. In high voltage x-ray tubes, as

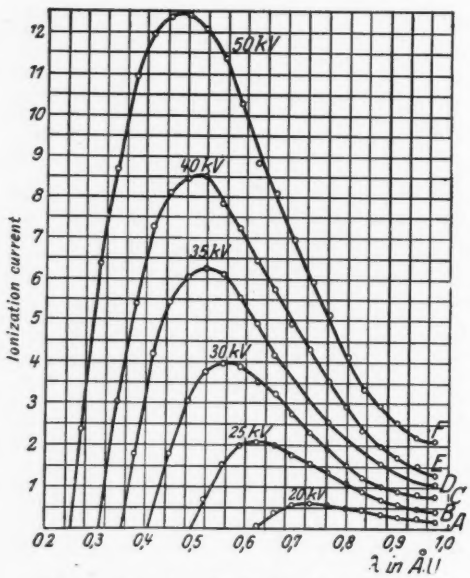

Fig. 4. Intensity distribution (uncorrected) of the continuous radiation from a tungsten anticathode at various voltages, taken by Ulrey.

well as diagnostic x-ray tubes, water and oil are caused to circulate through the target and cooled in very much the same manner as automobile engines are cooled. The water may be circulated through the target by means of pumps, or it may be allowed to circulate due to gravity; the warm water, rising to the surface, causes a circulation of water.

Kind of X-rays.—General x-rays are electromagnetic waves generated at the face of the target of the x-ray tube by the sudden stopping of the fast moving electrons. The wave lengths of these x-rays may vary from the longest wave length that can penetrate the walls of the x-ray tube to the shortest wave length that can be produced by the highest peak voltage applied to the target. This is due to the successive stages of absorption of the fast moving electrons from the filament and the variation in the velocity of the electrons due to the variation of the voltage on the target. Since at each successive impact stage the velocity of the electron is reduced, x-rays of different wave lengths corresponding to the different velocity stages of the electron are produced, the beam of x-rays consists of a heterogeneous group of x-ray wave lengths.

An x-ray spectrum for general radiation is the same for all elements. Superimposed upon the general radiation spectrum, there is a characteristic, or fluorescent radiation with definite wave lengths, or frequencies for each element. When the electron from the filament attains sufficient velocity, which is a function of the voltage, it may enter the atomic sphere of the tungsten atom, displacing one or more orbital electrons. It requires energy to displace the orbital electron, or electrons, because the orbital electrons are held in position due to the mutual attraction of unlike charges between the nucleus and orbital electrons and the force of repulsion between orbital electrons, since like electrical charges repel. Consequently when the expelled electrons, or some other adjacent free electrons, drop back into their atomic spheres, the energy required to eject the orbital electrons is given out in the form of radiation which is characteristic of an atom of a particular element. This type of radiation is known as characteristic, or fluorescent. The voltage necessary to produce characteristic radiation is a function of the atomic weight. As the atomic weight increases, the necessary voltage to energize the atom increases. Mosley determined the x-ray spectrum for a sequence of elements and learned that characteristic radiation occurred with a definite regularity from element to element.

Wave lengths of characteristic radiation have been measured and are designated K, L, M, and N, which represent the position with respect to the nucleus, the K radiation arising from the energy given up by an electron nearest the nucleus and N radiation from electrons farther away from the nucleus.

The wave lengths of K radiation are shorter and are considered about 300 times more penetrating than the L radiation. Likewise, the L radiation is more penetrating than the M radiation.

A curve representing an x-ray spectrum

of radiation from a tungsten target, plotting wave lengths and corresponding wave length intensities, will show general radiation as a smooth curve. Superimposed on the general radiation curve, narrow bands of wave lengths with high intensity peaks will be seen. These intensity peaks represent characteristic radiation from the energy given up by ejected electrons from their respective electronic orbits of the tungsten atom.

Figure 4 represents measurements of radiation intensities for different wave lengths in the x-ray spectrum for general x-rays generated by voltages ranging from 20 kv. to 50 kv. (Ulrey). The voltages are not sufficiently high to include characteristic radiation. The area under each voltage curve represents the total radiation intensity. It will be noted that as the voltage is increased from 20 kv. to 50 kv., the total intensity increases. It will also be noticed that with each increased voltage curve there is a decrease in the minimum wave length. An increase in the total intensity and a shorter minimum wave length following an increase in the voltage applied to the target is to be expected, since the speed of the electrons from the filament and the force of impact of the electrons on the face of the target are increased.

SUMMARY

The main features in the production of x-rays have been discussed, covering the following subjects: (1) construction of x-ray tubes; (2) high voltage and low voltage transformers; (3) control of high voltage and milliampere current; (4) rectification of high voltage current; (5) mechanics involved in generating x-rays; (6) kinds of x-rays; (7) variation of the x-ray spectrum with a change in voltage and milliampere current.

(To be continued)

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POSTERIOR DISLOCATION OF HIP

ROENTGENOGRAPHIC STUDY IN THE ANTERIOR OBLIQUE VIEW

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IN posterior dislocation of the hip, it is essential to have roentgenographic examinations to determine the exact nature of the pathologic changes and to check the therapeutic results. Ordinarily, the examination is made in the standard anteroposterior position, with the patient lying flat on his back over the Potter-Bucky diaphragm and the film; the central x-rays are directed to the film perpendicularly through the region of the hip. This technic yields excellent exposition of the relationship of the femur and the acetabulum of a normal hip, especially in the stereoscopic view. However, in posterior dislocation the head and neck of the femur are hidden under the blade of the ilium and, consequently, the shadows of these parts are superimposed. The extent of displacement may be quite evident, but even with stereoscopic study, it is often impossible to examine the bones separately so as to visualize exactly the nature of the changes and also the relationship between the femur and the ilium.

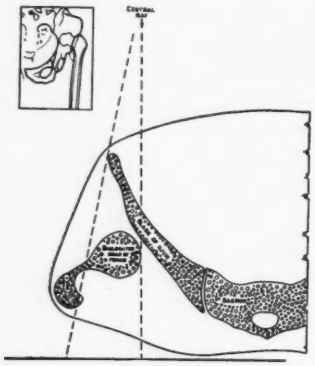

Fig. 1. Illustration of the anatomical parts shown in posterior dislocation of the left hip in the standard anteroposterior technic. The inset shows the resultant view, with the superimposition of the shadows of the ilium and femoral head.

In order to separate the shadow of the dislocated head of the femur from that of the blade of the ilium, the writer has employed a new technic using the anterior oblique view. The patient lies obliquely on his abdomen, with the antero-lateral portion of the crest of the ilium of the affected side resting on the film. The unaffected side is elevated from the film or table at an angle of from 30 to 45 degrees and is supported by sand bags. The central x-rays are directed between the head of the femur and the posterior surface of the blade of the ilium. The resulting roentgenogram presents an anterior oblique view in which the bones are projected on the film separately, without superimposition. Figures 1 and 2 illustrate the technic of the two projections and the anatomical relationship of the bones in the anteroposterior and anterior oblique views.

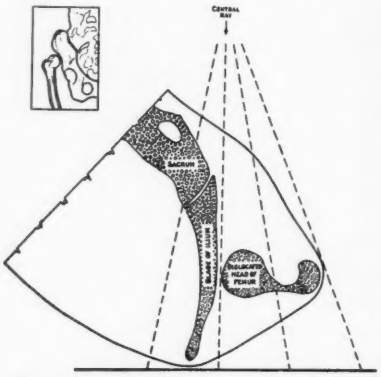

Fig. 2. Illustration of the anatomical parts shown in posterior dislocation of the left hip in the anterior oblique technic. The inset shows the resultant view, with separation of the shadows of the ilium and femoral head.

In acute traumatic posterior dislocation, the anteroposterior view is usually sufficient for ordinary purposes. In all other types of dislocation, however, the anterior oblique view is more helpful since various

pathologic changes (*i.e.*, absorption or destruction of bone, proliferation of bone, formation of a false or new joint, and bony ankylosis between the femur and ilium) cannot be visualized accurately in the routine anteroposterior view. Any of these pathologic changes may influence the surgeon in making the choice of indications for treatment, *i.e.*, whether it is to be conservative (manipulative) or operative. The writer has used the anterior oblique technic in many cases during the past eight years, and in his experience this method has proved very useful. The following case records and illustrations show the advantages of the technic.

Case 1. A boy, 18 years of age, was first seen on June 20, 1927, in the outpatient clinic, for deformity of the right hip joint which had developed gradually during the preceding eleven years. Physical examination revealed findings which suggested posterior dislocation of the right hip joint, probably due to a tuberculous process or to injury. Roentgenologic examination in the anteroposterior position (Fig. 3) showed a high iliac dislocation of the right femur. The femoral head was poorly visualized and appeared rarefied, small, and deformed, resting against the blade of the ilium, but the degree of new joint formation could not be determined. The primary acetabulum was practically absent. The roentgenologic diagnosis was congenital dislocation of the right hip.

The patient entered the hospital for operative treatment on Sept. 21, 1927, and while there he admitted having had an abscess in the right hip region, which was incised and drained 14 years previously. The abscess finally healed, but limping had been present ever since. This additional information suggested a diagnosis of suppurative arthritis with pathologic dislocation of the hip.

A "shelving operation" was performed on Sept. 30, 1927. Subsequent clinical examinations showed that the patient's condition was not greatly improved. Repeated x-ray examinations in the anteroposterior position showed gradual absorption of the bone grafts and no new bone formation.

In an attempt to try to find out the exact nature of the pathology, an anterior oblique view (Fig. 4) of the hip was made one and one-half years after the operation

Fig. 3. Case 1. Anteroposterior view. The femur is dislocated posteriorly and superiorly. The structures of the femoral head and neck and the posterior surface of the ilium blade cannot be clearly visualized.

Fig. 4. Case 1. Anterior oblique view. The posterior surface of the ilium is viewed in profile, showing a raised articular process. The femoral head appears "mushroomed," and the femoral neck shortened and thickened. Note that these changes cannot be visualized in Figure 3.

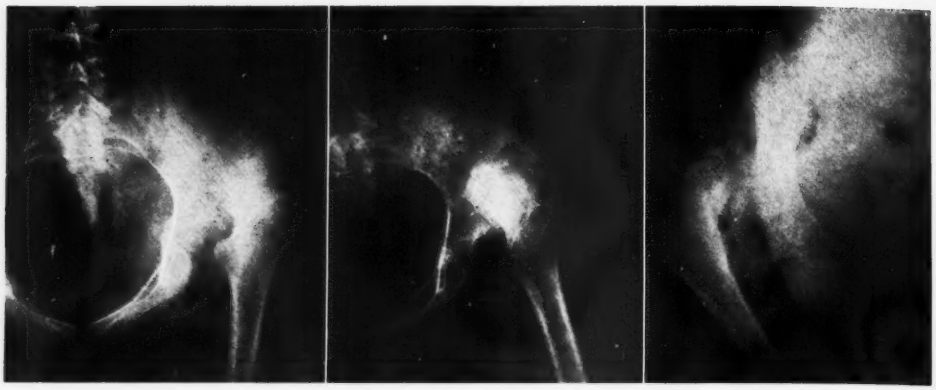

Fig. 5. Fig. 6. Fig. 7.

Fig. 5. Case 2. Anteroposterior view, showing destruction of the acetabulum, postero-superior dislocation of the femur, and also erosion of the bones of the sacro-iliac articulation.

Fig. 6. Case 2. Anteroposterior view taken three and one-half months after that shown in Figure 5, showing less haziness and irregularity of the involved bones. The exact condition of the femoral head and ilium cannot be determined.

Fig. 7. Case 2. Anterior oblique view taken on the same date as that shown in Figure 6. The changes of the femoral head and neck of the iliac blade are clearly demonstrated; also, bony ankylosis can be seen.

(Feb. 2, 1929). This roentgenogram demonstrated findings which all previous anteroposterior examinations had failed to show. The neck of the femur was very much shortened and thickened; also, the head was flattened and widened at the base (mushroomed), its articular surface being smooth and articulated, with a peculiar shallow fossa formed by a projected disc of new bone on the blade of the ilium. These findings suggested that a satisfactory articular process had been formed to accommodate the deformed head of the femur.

After reviewing this oblique view, the surgeon who operated upon the patient made the following statement on Feb. 2, 1929: "The oblique view was very enlightening, showing an interesting picture of an absence of the true acetabulum and a shallow false one, into which a flattened head projected. The peculiar shape of the head and neck of the femur is difficult to explain, possibly Perthes' disease could account for it; congenital dislocation is not likely. The presence of hypertrichosis and spina bifida in this case also lead one to suspect myelodysplasia as a possible diagnosis. Had I previously seen a roentgenogram taken at the angle of this one, I would not have recommended operation. The shelf of bone which I placed in the iliac blade is too high to be effective."

Comment.—This is the first case in which the writer used the anterior oblique view to study posterior dislocation of the hip. It was tried in an attempt to answer the request of the orthopedic surgeon who wished to determine more exactly the nature of the pathologic changes. The surgeon's note points out clearly the additional value of films taken with this technic.

Case 2. A Chinese girl, aged 19 years, came to the hospital on Jan. 19, 1928, with a history of having twisted her left leg two months previously. Soon after the injury the patient became bed-ridden with an attack of high fever for a period of two weeks. This was associated with pain and swelling in the region of the left hip. Physical examination showed tilting of the pelvis with 5 cm. shortening of the left lower extremity. The greater trochanter of the left femur stood out very prominently and pressure over it produced much pain. All motions of the left femur were limited and painful. A tense, tender swelling of the left hip region was present. In the region of the Poupart's ligament, there was another tender swelling, which

could be traced to join a large tender mass filling the entire left lower quadrant of the abdomen. The clinical diagnosis was tuberculosis of the left hip joint and tuberculous abscess of the left lower quadrant.

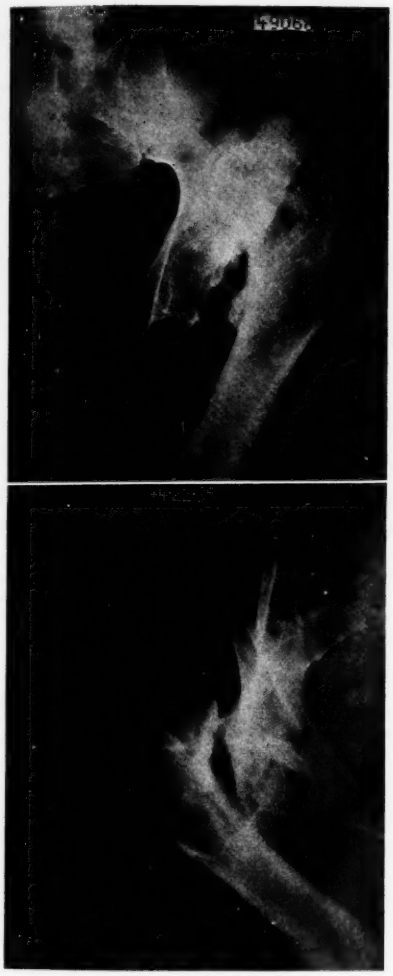

Fig. 8. Case 3. Anteroposterior view, showing posterior dislocation of the femur. There is a socket-like structure on the blade of the ilium superimposed over that of the femoral head. New bone formation is seen.

Fig. 9. Case 3. Anterior oblique view, showing a glenoid type of articular process on the blade of the ilium. There is no evidence of bony ankylosis.

Roentgenologic examination in the anteroposterior position (Fig. 5) revealed extensive destruction of the left sacro-iliac articulation and the blade of the left ilium; also, the left hip joint showed posterior dislocation.

Fig. 10. Case 4. Anteroposterior view, showing posterior dislocation of the femur.

Fig. 11. Case 4. Anterior oblique view, showing a femoral head which is small, deformed, and osteoporotic.

The patient was discharged to continue conservative treatment in another institution. Roentgenologic examination on June 30, 1928, showed some evidence of repair in the left sacro-iliac and hip joints. There was also new bone formation in the

head and neck of the femur and the blade of the ilium.

Another roentgenologic examination was made on May 8, 1929, including for the first time an anterior oblique view. The anteroposterior view (Fig. 6) showed less clouding and irregularity of the involved bones of the hip and sacro-iliac regions. In the anterior oblique view (Fig. 7), the changes in the head and neck of the femur and the blade of the ilium were clearly demonstrated. On the posterior surface of the blade of the ilium there was a raised, well-formed disc of new bone, the surface of which was slightly concave and conformed to the shape of the deformed head and neck of the femur resting on it. A large part of the head and neck of the femur had been destroyed, and their surfaces were dense and irregular and had spicules bridging into the new disc of the ilium, indicating early bony ankylosis.

Conservative treatment was continued until November, 1929, when the patient was brought to the hospital for operative treatment. Because of the physical finding of slight motion of the left femur, an open reduction in two stages was decided upon. On Nov. 18, 1929, the left hip was opened and explored. Contrary to the clinical impression, the dislocated femoral head was found to be firmly united with the blade of the ilium, as demonstrated in the roentgen films taken six months previously. In order to correct the flexion and adduction deformity of the lower extremity, the operative indication was then changed and a simple subtrochanteric osteotomy was done. The post-operative result was excellent. Recently the patient has been leading an active life as a teacher.

Comment.—The anteroposterior view did not show the bony ankylosis which was apparent in the anterior oblique view. Comparison between the clinical and the roentgenologic findings showed that the latter allowed a more accurate diagnosis as to the nature of the ankylosis.

Case 3. A Chinese man, 42 years of age, came to the out-patient clinic with a history of fracture of the left femur eight years previously while in Russia. He had been hospitalized and treated there for about five months, with partial recovery, but continued to have pain and weakness of the limb during walking. Physical examination showed that the greater trochanter of the left femur protruded backward and upward, and there was a bony prominence at the medial aspect of the upper end of the left thigh, which was tender upon pressure. The left lower extremity showed 5 cm. shortening. Movements of the left hip were limited, especially in flexion and abduction. The clinical impression was old fracture of the upper part of the left femur.

Roentgenologic Examination.—The anteroposterior view of the left hip region (Fig. 8) showed a posterior dislocation of the hip, with new bone on the posterior surface of the ilium forming a new socket for the dislocated head of the femur. The nature of the new joint could not be determined even with stereoscopic study because of the superimposition of the parts. There was also evidence of an old fracture of the lesser trochanter.

In the anterior oblique view of the left hip region (Fig. 9), the head of the femur was visualized separately from the posterior surface of the ilium. It showed a new joint of the glenoid type. There was no evidence of bony ankylosis between the femur and the ilium, in spite of the presence of fragments of bone scattered in that area.

Other roentgenograms also showed an old united fracture of the middle third of the left femur.

The patient was not treated since the function of his left hip and leg was quite satisfactory.

Comment.—Without the anterior oblique films, the new joint could not be clearly demonstrated, and the surgeon might have explored the joint with the hope of improving the condition as in Cases 1 and 2.

Case 4. A boy, 18 years of age, was admitted to the hospital because of limping of four years' duration, which followed a

fall on the left hip. Physical examination revealed evidence of old posterior dislocation of the left hip joint.

Roentgenologic examination in the anteroposterior position (Fig. 10), confirmed the clinical findings of posterior dislocation. The anterior oblique view (Fig. 11) showed old deformity and slight osteoporosis of the head of the femur which was not evident in the other view. Also, the femoral head was found to be resting free opposite the blade of the ilium. There was no formation of new bone.

Following preliminary traction, which drew the femoral head down near the acetabulum, a successful open reduction was performed.

Comment.—In this case, the anterior oblique view demonstrated clearly the condition of the head of the femur, and served as a guide to the surgeon in his selection of the type of treatment.

IONIZATION OF AIR BY LENARD RAYS

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ABSTRACT

Lenard rays in atmospheric air have been measured by means of simple ionization chambers. At ordinary intensities, encountered with Lenard rays, it is impossible to saturate such ionization chambers and this has resulted in neglect of the method for practical purposes. It has been found, however, that plotting the reciprocal current against the reciprocal voltage, a straight line results, which can be extrapolated to $1/V = 0$; thereby giving the current at infinite field. A number of such cases are given. Unipolar conductivity is evident in at least one ionization chamber.

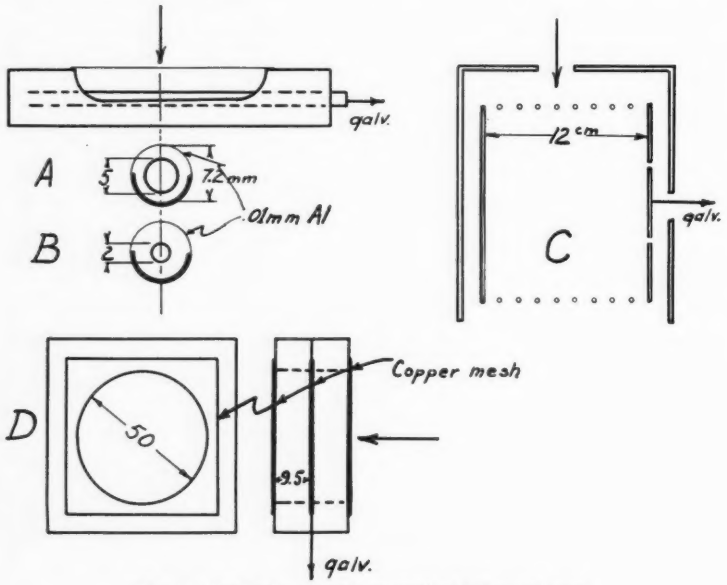

Fig. 1. Ionization chambers used with Lenard rays.

I. INTRODUCTION

IN 1930 a study was undertaken to arrive at a reliable method for measuring Lenard rays in such applications as the activation of ergosterol and the study of cathode ray biological effects.[1]

By intensity of Lenard rays is meant the rate of passage of electrons across unit area normal to the beam.[2] This does not involve the velocity distribution of the electrons within the beam. After investigating several, it was decided that the most direct method of measuring Lenard ray intensities was probably that employing a Faraday collector.[3]

On the other hand, the measurement of Lenard rays with an ionization chamber involves problems analogous to those commonly encountered in the measurement of x-rays and has the important advantage of being more simply related to the absorption in biological media. The ionization current is proportional to the fractional part of the energy of the whole beam, which is absorbed in the measuring volume of the chamber. This in turn depends upon the quality or velocity distribution of the electrons—a quantity which, at best, can only be expressed in

[1] This work was discontinued in 1932, and since the apparatus has largely been disassembled, it is not feasible at present to investigate further some of the problems suggested by a study of the old data.

[2] L. S. Taylor, RADIOLOGY, 1929, **12**, 294.

[3] L. S. Taylor, B. S. Jour. Research (RP 332), 1931, **7**, 57.

terms of some average distribution or composite absorption coefficient.[4]

In addition, the air ionization method of measurement offers a convenient mode of control and is presumably proportional to the intensity of a given quality. The use of a simple ionization chamber was tried, but it was abandoned because of inability to reach saturation without causing a disruptive breakdown of the air by collision ionization under the high electrostatic fields employed.

Recent studies[5] have led to an application of Jaffé's theory of columnar ionization,[6] whereby it is possible to derive the saturation current value in liquids exposed to x-rays. Clay and Van Tijn[7] and Zanstra[8] have independently arrived at similar results in the case of high pressure gaseous ionization chambers exposed to gamma rays. These studies have led us to investigate the shape of the saturation curves produced by Lenard rays in air at normal pressure.

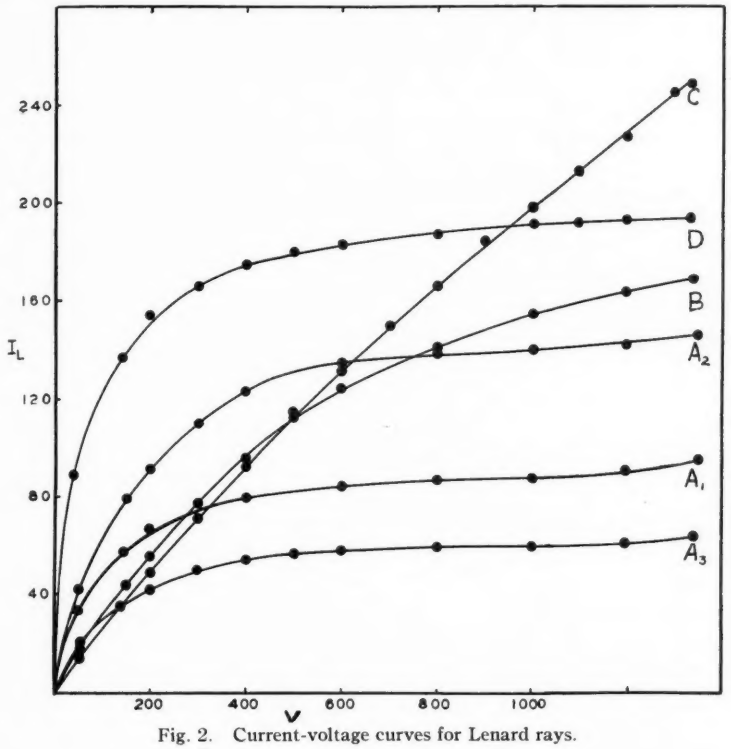

Fig. 2. Current-voltage curves for Lenard rays.

II. EXPERIMENTAL ARRANGEMENT

The detailed description of the apparatus has been given in an earlier paper.[9] The cathode rays were produced in a sealed-off Lenard tube with a thin glass window designed by Slack[10] and operated from a high voltage source of the Villard rectifier type. The voltage was approximately a sine wave above ground with a peak value of 150 kv. Input voltage was supplied by a synchronous motor generator set and

[4] L. S. Taylor, B. S. Jour. Research (RP 666), 1934, **12,** 401; RADIOLOGY, 1934, **22,** 445.

[5] F. L. Mohler and L. S. Taylor, B. S. Jour. Research (RP 733), 1934, **13,** 659.

[6] G. Jaffé, Ann. Phys., 1913, **42,** 303.

[7] J. Clay and M. A. Van Tijn, Physica, 1935, **2,** 825.

[8] H. Zanstra, Physica, 1935, **2,** 817.

[9] L. S. Taylor, B. S. Jour. Research (RP 337), 1931, **7,** 57.

[10] C. M. Slack, Jour. Opt. Soc. Am., 1929, **18,** 123.

hence reasonably steady. Output voltage was controlled and measured directly with a high resistance voltmeter. Tube current, measured between anode and ground, was maintained at 21×10^{-6} amp.

The ionization chamber was mounted on a track in front of the tube window. The ionization current (10^{-7} to 10^{-8} amp.) was measured with a galvanometer connected between the chamber and tube anode. One set of measurements for currents of about 10^{-10} amp. was made with a capacitance compensator and electrometer.[11]

Ionization chambers (Fig. 1) of the following descriptions were used: *A*, cylinder, brass tube 7.2 mm. inside diameter, cut away for about half its circumference and covered with 0.01 mm. of Al; collector rod 5 mm. diameter; opening length 5 cm. *B*, same as for *A*, except collector rod was 2 mm. diameter. *C*, parallel plate, guarded field ionization chamber[12] with snout and back removed. *D*, parallel copper mesh (32), 1 cm. spacing, 5 cm. diameter. *E*, cylinder copper mesh (32), 8 mm. inside diameter, collector 2 mm. diameter. Chamber A was used with three different Lenard ray qualities, distinguished by A_1, A_2, and A_3 in the text and plots.

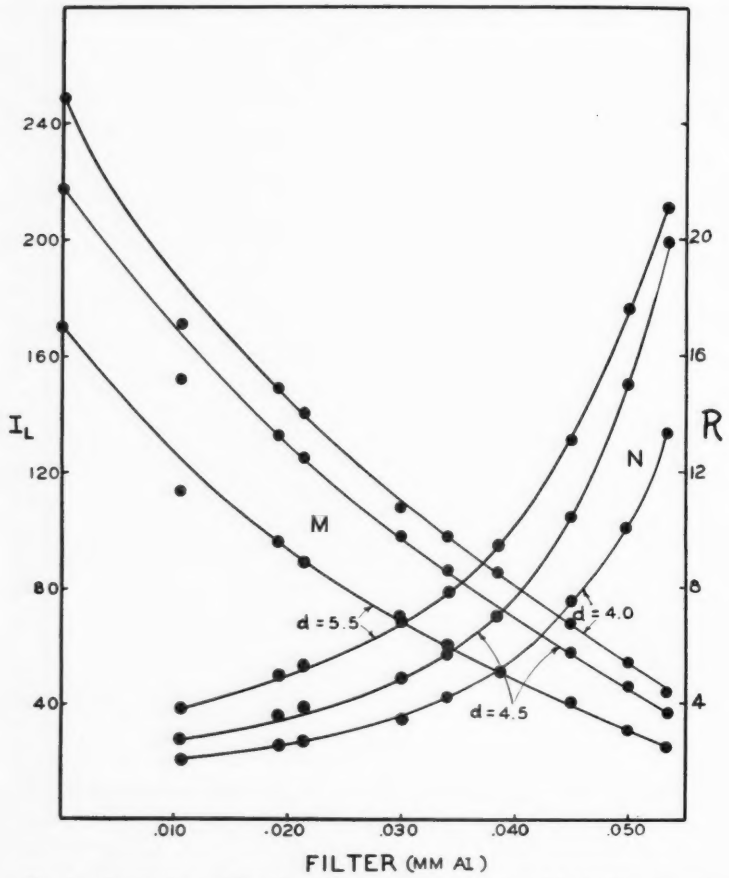

Fig. 3. Comparison of Faraday chamber measurement and ionization measurement of Lenard ray.

[11] L. S. Taylor, B. S. Jour. Research (RP 306), 1931, **6**, 807.

[12] L. S. Taylor and G. Singer, B. S. Jour. Research (RP 211), 1930, **5**, 507.

The Lenard ray beam was limited in cross-section by a thin metal diaphragm placed in front of the tube window. This diaphragm had a diameter of 14 mm., with A, B, and E, 2.9 mm. with C, and 1.9 mm. with D.

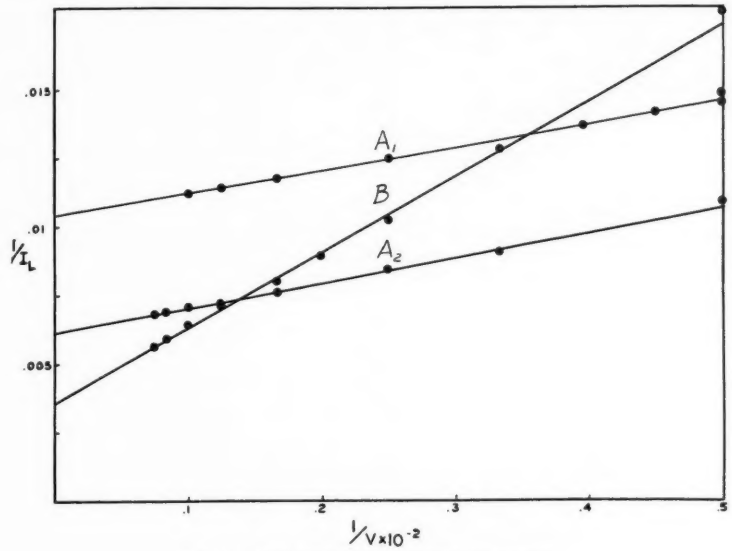

Fig. 4. Reciprocal current-voltage curves.

III. EXPERIMENTAL RESULTS

1. *Current-voltage Curves*

Curves for the ionization current as a function of the applied voltage are given in Figure 2 for chambers A to D. Applied voltage rather than field strength is used as abscissas since the latter is indeterminate. It is seen in the case of curves A_1, A_2, and A_3 that noticeable collision ionization begins at about 1,000 volts, which corresponds roughly to a field strength of about 9 kv./cm. In all other cases, this high field strength was not approached, and no evidence of collision ionization was noted.

It is also to be noted that at high field strengths, saturation is nearly reached, whereas for the very low fields used in parallel-plate chamber C there is no apparent evidence of approach to saturation.

It was not possible to vary the degree of the ionization by a known amount without at the same time introducing other variables, such as electron diffusion and change in velocity distribution. Hence, there is no simple direct way to ascertain whether or not the ionization current below saturation is proportional to the radiation intensity. This was attempted by indirect means. Previous studies have indicated the reliability of a Faraday collector for measuring the Lenard current.[9] The intensity of the beam was therefore varied by filtering with thin aluminum foil, and absorption curves of the resultant radiation obtained first with the Faraday chamber and then with ionization chamber A at 900 volts, which is probably within 10 per cent of saturation. This was done for three different distances, d, between the tube window and Faraday collector or ionization chamber.

Figure 3 shows the results, where curves M are for the ionization chamber and curves N are for the ratio R of the ionization current to the Faraday current. On the assumption that the measurements by the Faraday chamber are correct, the relative sensitivity of the ionization chamber changes rapidly, increasing as the ionization becomes weaker.

An explanation for the apparently great disparity between the measurements by the two methods probably lies in the fact that whereas the Faraday collector measures the total Lenard current, the ionization current gives only a measure of the fraction of the energy of the electrons absorbed within the ionization chamber. With no filter, fast cathode rays with low ionizing power pass completely through the chamber. With increase in filtration an increasing fraction of the electrons terminate their paths within the chamber, and thereby produce a greater amount of ionization in accordance with Bragg's findings in terminal ionization.

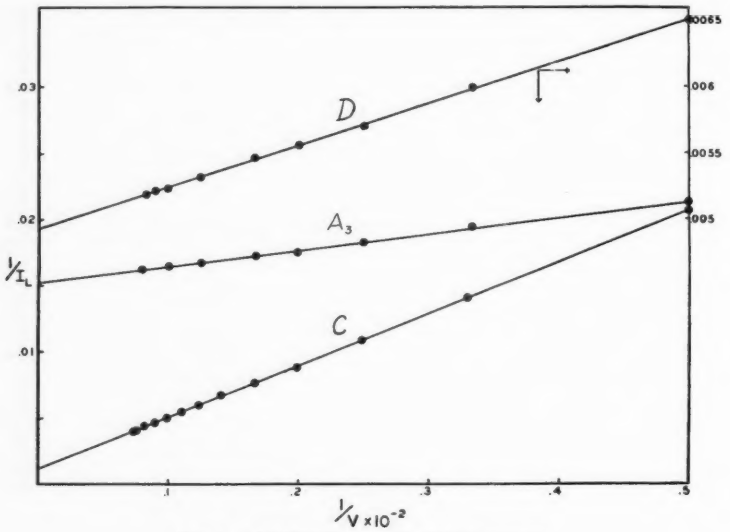

Fig. 5. Reciprocal current-voltage curves.

2. *Reciprocal Current-voltage Curves*

Suggested by the results of plotting the reciprocal current against reciprocal voltage in the case of liquids (Mohler and Taylor) and high pressure gases (Zanstra), the above data were similarly treated on purely empirical grounds.[13] Such a plot compresses the scale at the upper voltages so that an extrapolation to infinite fields is rendered practical.

The data of Figure 2 were accordingly plotted with the reciprocal current against the reciprocal voltage in Figures 4 and 5. It is seen that even down to comparatively low field strengths there is a linear relationship between the two quantities. In the case of chamber A, the field strength of 9.0 kv./cm. gave very nearly the saturation current, as shown in Figure 2. It would appear safe, therefore, to extrapolate the curve to $1/V = 0$, thereby deriving a magnitude for the ionization current I_∞ at infinite field.

Similarly the other curves are extrapolated to $1/V = 0$, since they are straight lines even in the extreme case of chamber C where the maximum field strength was about 0.15 kv./cm. Table 1 gives a summary of the experimental factors and also the ratio I_v/I_∞ of the highest measured current I_v, to the derived maximum I_∞.

With the exception of chambers C and D, the field strengths given do not have great significance—especially those marked with an asterisk—since in all cases, the field is radial and hence not uniform. In chambers A_1, A_2, and A_3 the radii of the inner and outer cylinders are 2.5 and 3.6 mm., respectively, so the field is considerably more uniform than in chambers B and E.

[13] L. S. Taylor, Phys. Rev., 1935, **48,** 970.

The effect of reversing the potential on the chamber is shown in Figure 6 for the cylindrical chamber E. From the simple lack of sufficient definition of the beam and ionized volume. The effective volumes of chambers A_2 and B are roughly in the ratio

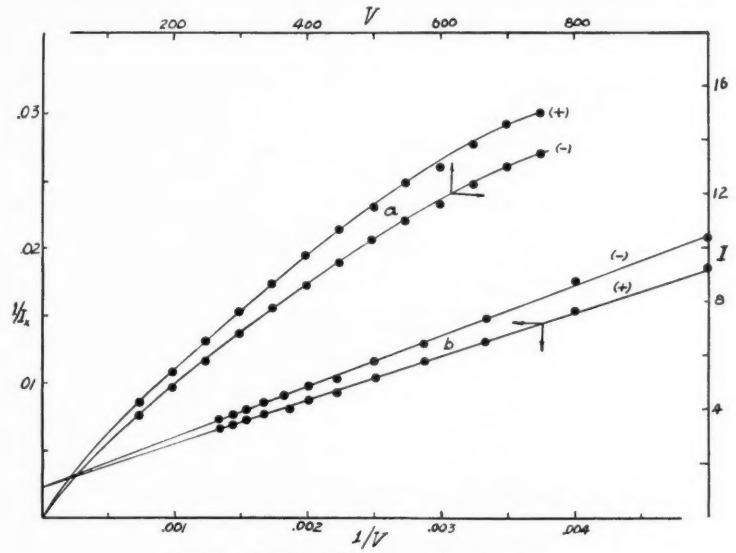

Fig. 6. Reciprocal current-voltage curves.

current voltage curves, *a*, it is seen that with a negative potential on the collecting electrode, the ionization current is substantially larger than when it is positive. Curves *b* show the same data plotted reciprocally; it is seen that although the points fall on two distinct straight lines, they extrapolate to the same value of $1/I_v$ for $1/V = 0$.

TABLE I.—LENARD RAY INTENSITIES

Chamber	Tube distance† cm.	Tube diameter (mm.)	Filter (mm.)	Maximum field strength kv./cm.	I_∞ Amp. $\times 10^{-6}$	$\frac{I_v}{I_\infty}$
A_1	7.3	14		9.1	17.1	0.91
A_2	4.6	14		9.1	53.8	.86
A_3	4.6	14	0.2 Al	9.1	21.6	.93
B	4.6	14		*3.2	91.2	.51
C		2.9		.13	29.3	.28
D	6.6	.9		1.4	6.65	.90
E_1	4.6	14		*2.5	77.8	.35
E_2	4.6	14		*2.5	77.8	.35

† Airpath between tube window and ionization chamber.

Included in Table I are the values of I_∞, which may be used for rough calculations of the ionization per unit volume, absolute values of which cannot be obtained for of 1:2, with which the respective values of I_∞ agree.

IV. DISCUSSION

An attempt was made to explain the form of these ionization curves on the basis of some existing theory, but this is rendered too complicated by the inhomogeneous electric field in all chambers but C and D. The relationship between ionization current and field strength for a uniformly ionized chamber has been found by others to agree fairly well with the theories of Thomson,[14] Nice, and Seemann for x-rays and β-rays of moderate intensity (up to 5 roentgens per minute, for x-rays). However, the intensities involved here are of the order of 1,000 times as large, and hence initial and intercolumnar recombination may be of greater importance here than in the cases of low ionization densities.

Thomson's equation for the ionization

[14] See J. J. Thomson, Conduction of Electricity Through Gases, Cambridge, 1928.

current I_x at a given field strength X, where I_x is small compared with I_∞, is

$$\frac{I^2_x}{I_\infty - I_x} = \frac{(k_1 + k_2)^2 X^2}{\alpha/e.l}$$

where l is the plate separation, α the recombination coefficient, and e the charge on the electron. Taking the square root of both sides of this equation it is seen (curve C, Fig. 2) that for small values of I_x there is nearly linear relation between I_x and X. The conditions in the equation may be approximately fulfilled by the chamber C and possibly E where the ratios I_x/I_∞ were 0.28 and 0.35, respectively. It is, indeed, true that the curves are linear for these chambers, but it is equally true that they are linear for the other chambers where I_x/I_∞ is 0.9, a magnitude too large for fulfilling the conditions of approximations. Assuming that this relation holds for the maximum ionization current measured with parallel-mesh chamber D, it was found that the calculated current-voltage curve deviated by several per cent from the experimental curve even at the 98 per cent saturation point. That this might have been expected from the experimental results is obvious from the fact that for all conditions studied it was found that $1/I_v$ was proportional to $1/V$.

Likewise, Jaffé's theory of columnar ionization cannot hold under conditions here used, since it is based on the assumption that the columns do not overlap and that intercolumnar recombination is, therefore, negligible. On the other hand, Zanstra has evaluated the ionization current-voltage relationship for air over a wide range of pressure, and although the deviation from the curves for uniform ionization is marked at the high pressures, there is a barely perceptible effect at the lower pressures (8.8 atmosphere). We have no explanation as to why the present data appear to follow Jaffé's laws for columnar ionization.

Unipolar conductivity such as shown with chamber E has been explained on the basis of a marked asymmetry in the distribution of ionization in an ionization chamber.[15] Cases studied have usually been those in which the radiation beam passed near one plate, but it has also been pointed out that where the radiation strikes a plate, a somewhat similar condition would be set up by the relatively intense secondary radiation from the plate.

This condition probably obtains in the chambers employed in the present work. In addition, since the Lenard rays are absorbed strongly by air, the ionization density will be substantially less at the emergent side than at the entrance side of the chamber. Of particular interest, however, is the fact that regardless of the sign of the potential on the plates, the relationship of $1/I_x$ to $1/X$ is linear at high field strengths. Moreover, under the same radiation conditions both curves extrapolate to identically the same value of $1/I_x$ for $1/X = 0$. This latter fact would seem to definitely indicate the validity of a reciprocal current-voltage relationship and the permissibility of obtaining the true saturation current by extrapolation. For it is reasonable to expect the actual number of ions formed to be independent of any potential applied to the plates (except above the field strength where collision ionization occurs) and hence yield the same saturation current under conditions where no ions are lost by recombination.

The difference in ionization current at the lower fields might also be caused by electric field inhomogeneity, but it is interesting to note that exactly similar curves have been reported by Clay and Van Tijn[16] for a parallel-plate chamber with air under high pressure and using gamma rays as the ionizing agent. We have also found similar results for parallel-plate air ionization chambers with very intense x-rays.[17]

[15] E. Rutherford, Phil. Mag. [VI], 1901, **2,** 210.

[16] F. L. Mohler and L. S. Taylor, B. S. Jour. Research (RP 733), 1934, **13,** 659.

[17] Data to be published later.

THE EFFECT ON ROENTGEN RAYS AND HYDROGEN PEROXIDE ON TISSUE LIPASE

By HELEN QUINCY WOODARD, PH.D., Memorial Hospital, *New York City*

SINCE the chemical changes produced by roentgen and gamma rays in tissue are not well understood, it is of interest to study the effect of these types of radiation on tissue enzymes. Lipase is a suitable enzyme for such study, since Falk and his co-workers (1–7) have shown that the lipases of various tissues differ markedly in their relative actions on different esters, and that the lipase from certain malignant tumors shows similarities to that from embryonal tissue. Accordingly, we have studied the effect of roentgen rays on the lipolytic activity of extracts of Mouse Sarcoma 180 and of various normal animal tissues. We have also studied the effect of radiation on Mouse Sarcoma 180 *in vivo*.

METHOD

The method of Falk, Noyes, and Sugiura (1) was followed with some modifications. Since many of the lipase preparations employed in the present work were quite dilute, and consequently had only slight buffering action, the esters were neutralized prior to incubation with such dilute preparations. The effect of the experimental procedures on the *p*H of the lipase preparations was watched, and when *p*H change occurred the preparations were brought back to *p*H 7.0 before incubation. Two of the esters used as substrates by Falk and his co-workers were omitted in the present study. Glyceryl tryacetate was not used because it failed to give a clear titration end point with dilute lipase preparations. Ethyl benzoate was omitted because the previous workers reported that the behavior of various lipases toward ethyl and methyl benzoates was so nearly the same that it seemed unnecessary to study both.

Tissue extracts were irradiated in crystalizing dishes, the depth of the solution being from 2 to 3 cm. The radiation factors were: 200 kv ; filter = 2.2 mm. Al + 1.0 mm. celluloid; distance, target to bottom of dish = 43 cm.; intensity = 135 r/min.; dose = 10,000 roentgens. Tumors were irradiated *in vivo* through a hole slightly larger than the cross-section of the tumor in a lead shield 4 mm. thick. The factors were: 200 kv.; filter = 0.8 mm. Cu + 4.0 mm. celluloid; target-skin distance = 50 cm.; intensity = 44 r/min.; dose = 1,000 to 1,750 roentgens.

RESULTS

The chemical effect of roentgen radiation on non-living material is usually small (8 and 9). Preliminary work showed that this is also true of lipase preparations. It

TABLE I.—EFFECT OF ROENTGEN IRRADIATION ON THE LIPOLYTIC ACTIVITY OF TISSUE EXTRACTS OF DIFFERENT CONCENTRATIONS

Each figure represents one experiment

Extract	Conc. at Irradiation	Conc. at Incubation	Av. Change of Absolute Activity
Rabbit liver A	50 mg./c.c.	50 mg./c.c.	+ 3%
	50 "	25 "	− 2%
	50 "	10 "	− 3%
	50 "	3 "	− 2%
	50 "	1.2 "	− 3%
	50 "	0.4 "	− 2%
	1.2 "	1.2 "	−23%
Rabbit liver B	10 mg./c.c.	10 mg./c.c.	−10%
	2.5 "	2.5 "	−12%
	1.0 "	1.0 "	−19%
Rabbit liver C	2.5 mg./c.c.	2.5 mg./c.c.	−11%
	1.0 "	1.0 "	−25%
Whole rat A	50 mg./c.c.	25 mg./c.c.	+ 2%
	50 "	1.0 "	+ 2%
	25 "	25 "	− 2%
	5 "	5 "	+ 3%
	2.5 "	2.5 "	−13%
	1.0 "	1.0 "	−10%
Whole rat B	50 mg./c.c.	50 mg./c.c.	+ 1%
	25 "	25 "	− 5%
	5 "	5 "	−10%
	2.5 "	2.5 "	−15%
Rabbit kidney	5 mg./c.c.	5 mg./c.c.	− 7%
	1.0 "	1.0 "	−14%
Rabbit lung	5 mg./c.c.	5 mg./c.c.	− 8%
	1.0 "	1.0 "	−32%

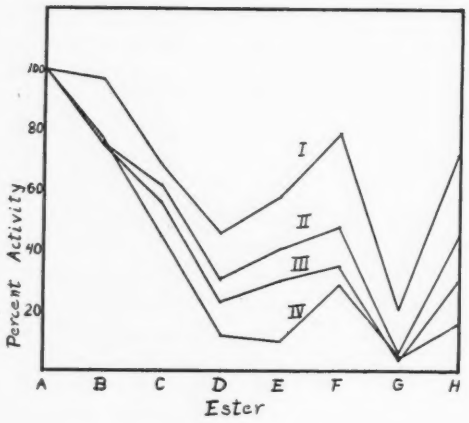

Fig. 1.

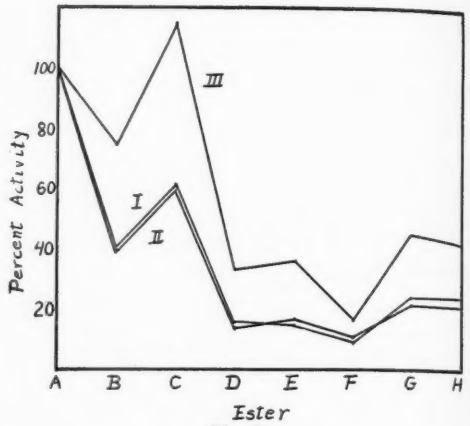

Fig. 2.

Fig. 1. The effect of concentration on the lipase "picture" of rabbit liver extract.[1]

Curve I = 50 mg./c.c.
" II = 10 "
" III = 1.2 "
" IV = 0.4 "

Each curve represents one experiment.

[1] Ester A = phenyl acetate.
" B = methyl butyrate.
" C = benzyl acetate.
" D = ethyl acetate.
" E = methyl acetate.
" F = ethyl butyrate.
" G = methyl benzoate.
" H = isobutyl acetate.

Fig. 2. The effect of 10,000 roentgens and of 0.010 M H_2O_2 on the lipase "picture" of Mouse Sarcoma 180 extract at 2.5 mg./c.c. concentration.

Curve I = irradiated extract, av. of 3 experiments.
" II = control extract, av. of 6 experiments.
" III = extract in 0.010 M H_2O_2, av. of 3 experiments.

seemed probable that, if concentrated solutions, in which only a portion of the enzyme was active, were irradiated and a small part of the enzyme were destroyed, then some of the previously inactive portion might become active and conceal the effect of the irradiation. In order to detect small amounts of inactivation, the determinations of lipolytic activity should, therefore, be made on extracts so dilute that the activity per milligram of original substance is nearly independent of concentration. Accordingly, a study was made of the effect of concentration on the activity of various lipase preparations. It was found that, for the most dilute extracts with which it was possible to work, the activity of the enzyme with respect to most of the esters was nearly independent of concentration, but this was usually not true of the activity with respect to phenyl acetate. With some preparations, this resulted in a marked change in "picture," as is shown in Figure 1 for an extract of rabbit liver. Another rabbit liver extract showed much smaller changes. Small changes in "picture" were also obtained with extracts of rat liver, rabbit kidney, rabbit lung, and whole rat. No significant changes of "picture" with concentration were found for extracts of rabbit muscle and Mouse Sarcoma 180. Whenever a change in "picture" was observed, the picture approached the embryonal type the greater the dilution of the extract. No attempt was made to determine the cause of this change in "picture," but it is possible that it is due to a change in the state of dispersion of the proteins associated with the enzyme. This is in harmony with the

observations of Falk (10) on the effect of added proteins.

EFFECT OF IRRADIATION *in vitro*

Extracts of rat and rabbit liver, rat spleen, rat muscle, rat kidney, rat lung, and whole adult rat were irradiated at 50 mg./cc. concentration and subsequently diluted. No definite radiosensitivity was observed. When, however, extracts were irradiated in dilute solution, the irradiated extracts were definitely inactivated, and the more dilute the extract at the time of irradiation (Table I), the greater the inactivation. In most cases the activity of the enzyme with respect to all the esters was diminished by about the same percentage; hence, only the average change is reported in the table. The figures for the activity toward methyl benzoate are not included in the averages, since the absolute activity of most lipase preparations toward this ester is so small that percentage changes are misleading.

In general, the enzyme "picture" was not changed by irradiation, as is illustrated in Figures 2 and 3. In a few experiments, changes in "picture" were observed, but were too small to be significant. The reduction in activity brought about by irradiation did not exceed 50 per cent in any experiment. This is not large enough to cause a change of "picture" in itself, since it was necessary to dilute extracts to $^1/_5$ or $^1/_{10}$ of the initial concentration before a change in "picture" became apparent, as is shown in Figure 1.

The absence of effect of irradiation on concentrated solutions is real, and is not due to the masking of small changes by the activation of previously inactive fractions which was discussed above. This may be seen by reference to Table I. Thus, Rabbit Liver Extract A and Whole Rat Extract A, when irradiated at a concentration of 50 mg./c.c. and then diluted to 1 mg./c.c., showed negligible radiosensitivities. The same extracts, when irradiated at a concentration of 1 mg./c.c., showed a diminution of activity due to irradiation of 23 per cent and 10 per cent, respectively.

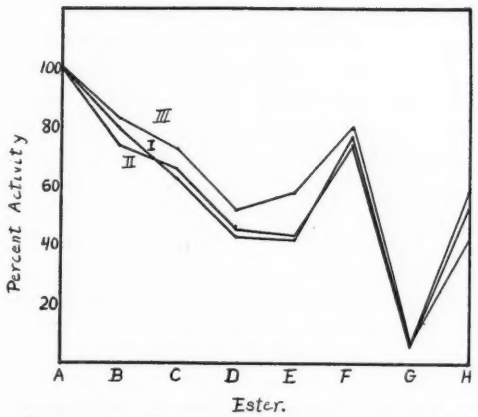

Fig. 3. The effect of 10,000 roentgens and of 0.010 M H_2O_2 on the lipase "picture" of rat liver extract at 1.0 mg./c.c. concentration.
Curve I = irradiated extract, av. of 2 experiments.
" II = control extract, av. of 5 experiments.
" III = extract in 0.010 M H_2O_2, av. of 3 experiments.

EFFECT OF HYDROGEN PEROXIDE

Since the enzyme is inactivated when irradiated in dilute solution, but shows no significant change in activity when irradiated in concentrated solution and subsequently diluted, it seems likely that the roentgen rays do not destroy the enzyme directly, but, rather, that some intermediate product is formed which inactivates the enzyme. This would explain the greater effect in dilute solution, since the ratio of the concentration of the intermediate product to that of the enzyme would be greater the more dilute the enzyme.

An attempt was made to demonstrate the production of this intermediate product. Distilled water brought to *p*H 7.0 with NaOH, and saturated solutions of toluene in water at *p*H 7.0, were irradiated with doses of 10,000 r. Concentrated lipase preparations were then diluted with irradiated, and control portions of these solutions and their lipolytic activities compared. In six out of ten experiments the lipase was slightly but definitely inactivated by the irradiated solution; in the other experiments the effect of irradiation was within the experimental error. The effect was not due to the action of roentgen

rays on toluene, since the results were the same whether it was or was not present.

It is well known that hydrogen peroxide is produced in low concentrations when water is irradiated. It, therefore, seemed likely that this was the substance the production of which in dilute enzyme solutions was responsible for their radiosensitivity. As hydrogen peroxide is also decomposed by roentgen rays, the equilibrium concentration is low. Experiments indicated that, under the conditions of the present work, the equilibrium concentration of hydrogen peroxide lay between 0.001 M and 0.0001 M. Such very dilute hydrogen peroxide solutions would not be expected to produce marked inactivation of lipase preparations added to them subsequent to irradiation, as was shown above. On the other hand, the total amount of hydrogen peroxide produced in a solution during the course of irradiation may well be large enough to inactivate appreciable amounts of enzyme, provided the enzyme is present in the solution during the course of the irradiation, and can take up the hydrogen peroxide before the latter is decomposed by further exposure to roentgen rays.

In order to test the effect of hydrogen peroxide, dilute lipase solutions were made up in solutions of "superoxol" of various concentrations, and their lipolytic activity compared with that of similar solutions made up in water. Hydrogen peroxide in concentrations below 0.010 M was found to have little effect, as was to be expected from the work on irradiated water reported above. The results with 0.010 M hydrogen peroxide are summarized in Table II. The activity of the enzyme toward phenyl acetate was usually diminished by a larger percentage than that toward the other esters, and hence is tabulated separately. Figures for the effect of irradiation on the same lipase preparations as those used for the hydrogen peroxide work are given for comparison. There is no parallelism between the magnitudes of the reductions in lipolytic activity effected by the two agents. Thus, roentgen rays reduced the activity toward phenyl acetate of extract of Mouse Sarcoma 180 by only 11 per cent, and hydrogen peroxide reduced it by 52 per cent, while the corresponding figures for rat liver extract were 42 per cent and 14 per cent. Other differences will be observed in the table. The marked change in "picture" away from the embryonal type, sometimes resulting from the differential action of hydrogen peroxide on the activity of lipase preparations toward phenyl acetate, is illustrated in Figure 2, and is contrasted with the much smaller change in Figure 3. The figures also show the absence of effect of roentgen rays on lipase "picture" even when, as in Figure 3, the percentage reduction of activity is large. Thus, while both roentgen rays and hydrogen peroxide inactivate lipase preparations, the two effects show such

TABLE II.—COMPARISON OF THE EFFECT ON THE LIPOLYTIC ACTIVITY OF TISSUE EXTRACTS OF 0.010 M H_2O_2 AND OF ROENTGEN IRRADIATION IN 10,000 r DOSES

Extract	Conc. Extract	Effect of H_2O_2		Effect of 10,000 r		No. Det'ns.
		On Esters Other than PhOAc	On PhOAc	On Esters Other than PhOAc	On PhOAc	
Rabbit liver A	10 mg./c.c.	− 3%	± 0%	− 9%	− 3%	1
	2.5 "	− 9%	− 9%	−14%	− 6%	1
	1.0 "	− 2%	− 8%	−20%	−14%	1
Rabbit liver B	2.5 mg./c.c.	− 9%	−11%	−11%	−12%	2
Rabbit muscle A	10 mg./c.c.	− 4%	−46%	−12%	−18%	2
Rabbit muscle B	10 mg./c.c.	− 7%	−32%	−23%	−30%	2
Whole rat	50 mg./c.c.	− 1%	−17%	+ 2%	− 2%	1
	2.5 "	−29%	−48%	−15%	−16%	2
Rat liver	1.0 mg./c.c.	− 4%	−14%	−44%	−42%	2
Mouse Sarcoma 180	2.5 mg./c.c.	− 6%	−52%	−12%	−11%	3

marked dissimilarities as to render it improbable that the production of hydrogen peroxide in irradiated solutions is responsible for all their radiosensitivity.

EFFECT OF IRRADIATION *in vivo*

The effect of roentgen irradiation of Mouse Sarcoma 180 *in vivo* also was studied. The tumors were irradiated when about two weeks old with doses of from 1,000 to 1,750 roentgens. All parts of the animal except the tumor were shielded with 4 mm. of lead. A dose of 1,500 r regularly produced a definite inhibition in the growth of the tumor, but did not cause retrogression in a period of one week. One week after irradiation the tumors were removed, the necrotic portions were discarded, and the healthy portions were extracted in the usual way. In one series the animals were inoculated with two tumors. One of these was irradiated, and the unirradiated tumor from the opposite side of the same animal was used as control. In the other series the controls were normal tumors from different animals inoculated at the same time as the ones used for irradiation. A total of nine experimental tumors and fifteen controls was used. When the four groups, tumors irradiated and inhibited, tumors irradiated and not inhibited, control tumors from animals bearing irradiated tumors, and control tumors from animals not bearing irradiated tumors, were compared, no significant difference was found in the lipase "pictures."

SUMMARY

The effect of roentgen rays and of hydrogen peroxide on the Falk lipase "pictures" of extracts of Mouse Sarcoma 180 and of various normal tissues has been studied.

When the lipolytic activities of portions of the same extract were compared over a wide range of concentration, the "picture" in some cases tended to approach the embryonal type the greater the dilution.

Roentgen rays in doses of 10,000 roentgens brought about a partial inactivation of the lipase in dilute extracts with little or no change in "picture." This appeared to be due to the formation by the roentgen rays of some intermediate inactivating substance in the solution rather than to a direct effect on the enzyme.

Hydrogen peroxide in 0.01 M concentration inactivated the lipase preparations with respect to phenyl acetate, but had much less effect on the activity toward other esters. This differential effect resulted in a change in the enzyme "picture" away from the embryonal type.

Irradiation of Mouse Sarcoma 180 *in vivo* did not result in any significant change in lipase "picture."

The author wishes to thank Dr. G. Failla, of the Physics Department, Memorial Hospital, for suggesting this problem, and Dr. K. Sugiura, of the Chemistry Department, Memorial Hospital, for supplies of tumor material and assistance in the work.

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AN IMPROVED METHOD FOR THE TREATMENT OF CANCER STATISTICS

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From The Cancer Institute, University of Minnesota Hospital

IN presenting cancer statistics it has become customary to state results as the percentage of so-called five-year cures. The hope that a patient who has lived five years without recurrence will be in no further danger of one is partly justified by the observation that about 95 per cent of recurrences make their appearance within a five-year period; however, this measure does disregard an appreciable proportion of the late recurrences. Moreover, the five-year-cure rate fails to account for the patients who die of causes other than cancer, and without evidence of recurrence. The common practice of listing such patients separately amounts to no more than transferring the statistical burden from the author to the reader, without helping in any way to solve the problem. Then, too, many authors publish data in terms of cure rates for other periods than five years. At present the only method of comparison between such data is reference to the original articles, and these often do not give sufficient details to permit comparison. These difficulties leave the problem of presentation in a very unsatisfactory state, and in view of the active research in this field improvement is imperative.

At first glance, correlation analysis would seem the solution to this problem; it would seem an easy and sure method of predicting length of life from such data as type of neoplasm, method of treatment, age, length of disease, etc., and the correlation coefficients would give comparison between the various methods of treatment in otherwise comparable groups. But closer inspection shows that the applicability is only superficial. The chief difficulty is the fact that practically all biologic data have "skewed" distributions, true normal or symmetrical distributions being the exception. Figure 1 shows an example of this: the solid line, which represents life expectancy at various ages, differs markedly from the superimposed normal curve. This "skewing" is prominent in most factors in cancer statistics: for instance, the age incidence of neoplasms is markedly asymmetrical, while such factors as form of treatment can be dealt with only by considering them point

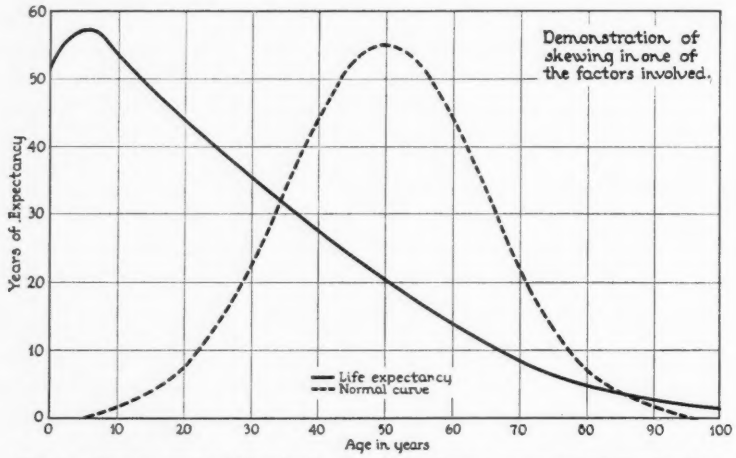

Fig. 1. Demonstrating "skewing" or deviation from a symmetrical distribution.

distributions of a discontinuous function. Since ordinary correlation analysis is based on the assumption that the distributions involved are sensibly normal, this divergence introduces important discrepancies, especially when comparisons are involved. Nor in a problem with such a large number of variables is it possible to apply the more

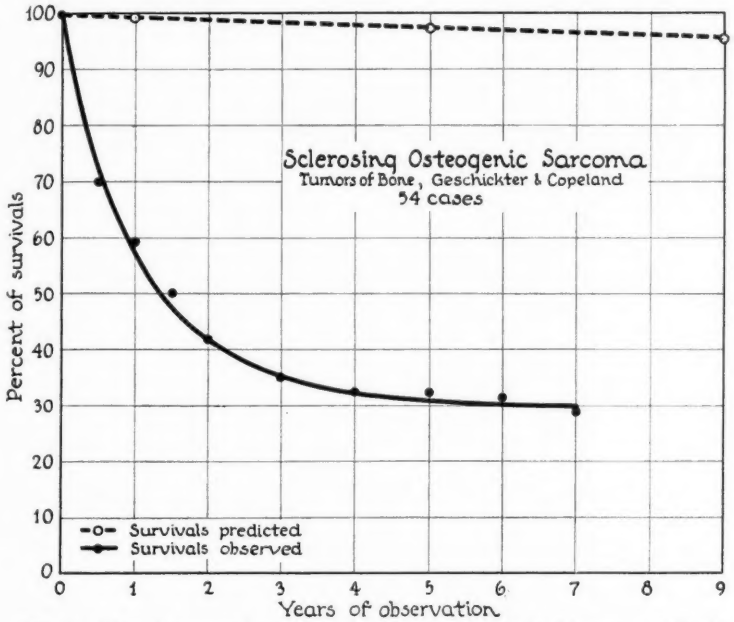

Fig. 2. Note that normal survival is almost 100 per cent in this group, while the actual survival observed only flattens out after about five years.

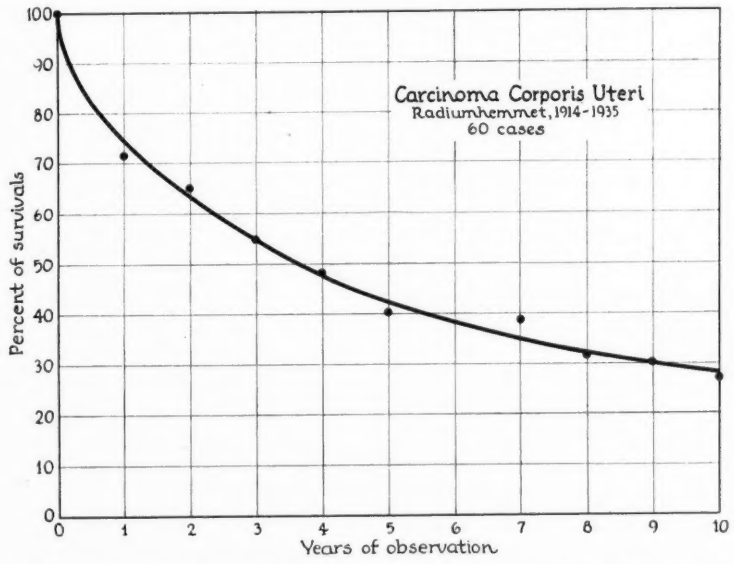

Fig. 3. Note that the curve never appreciably flattens, showing how misleading it is to speak of five-year cures in this condition.

general methods for approximating irregular correlation surfaces, as the number of cases is ordinarily too small.

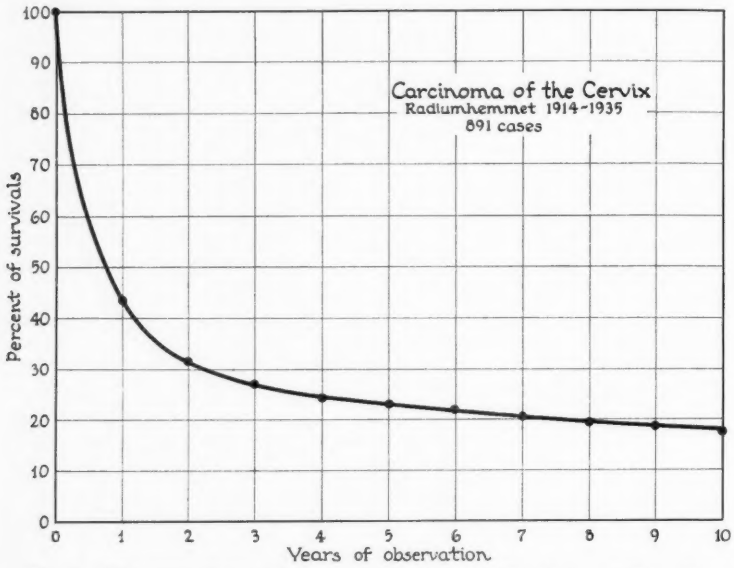

Fig. 4. The curve shows only a partial flattening, falling between those shown in Figures 2 and 3.

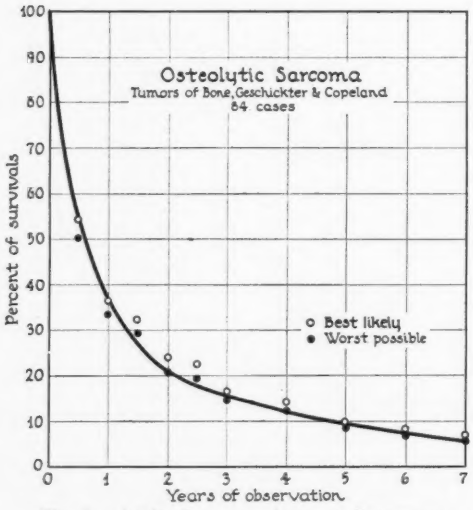

Fig. 5. Again the curve does not flatten out. Note that the partial follow-up hardly influences the location of the points, whichever assumption they be calculated upon. This is about 90 per cent follow-up for the seven years.

Then, too, ordinary correlation analysis assumes in calculating reliability that the conditions of simple sampling have been fulfilled, which is seldom the case in cancer statistics. Thus, a large state clinic is apt to receive those moderately developed cases which lend themselves to ready diagnosis outside, while those not so well developed or far advanced are less apt to be sent in, for obvious reasons. Moreover, there are definite changes with the passage of time in the incidence and distribution of cancer. Such selection invalidates the ordinary measures of statistical reliability, and the interpretation of results is correspondingly difficult.

In an attempt to solve some of these problems, the following method is presented for consideration. Let us set up a survival curve as a measure of results, stating the percentage of patients living year by year from first observation (Figs. 2, 3, and 4). Such a curve gives a succinct statement of results for as many years as there are data. Nor is it absolutely necessary that all patients be followed the same length of time, since each point may represent the percentage of patients followed that long, provided that the number at that point is large enough to assure reasonable accuracy, say, from 25 to 30 cases.

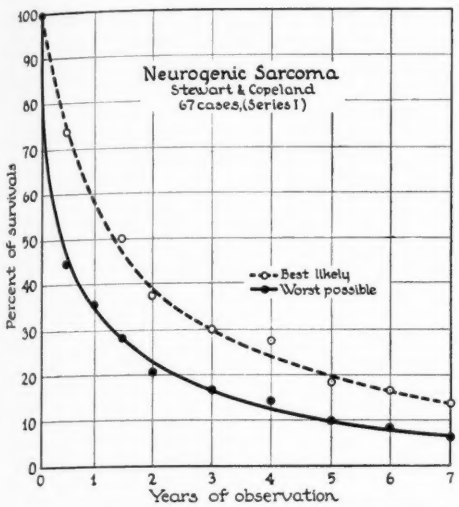

Fig. 6. This represents only 60 per cent follow-up (cases gathered from the literature), and demonstrates the use of two curves between which must lie the true survival curve.

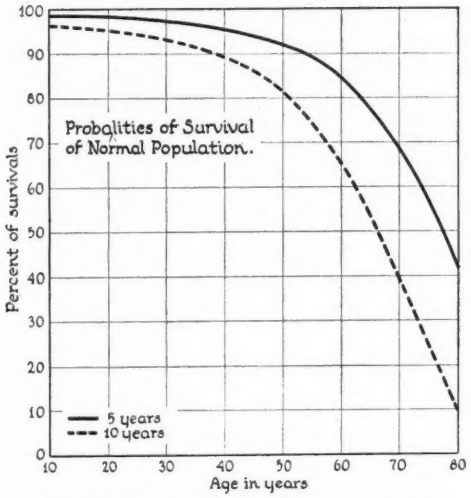

Fig. 7. Showing probability of survival for five years and ten years at various ages, the average of which for the cases in the series gives the dotted curve in Figure 2.

Comparison of such curves may then be made point by point, over as much or as little of the curve as is given, while a general comparison of the whole may be had by comparing the area encompassed under like time intervals of the two curves. With survival curves it makes less difference how long the series has been followed, except insofar as longer observation makes for greater accuracy, although three years is probably an absolute minimum, since shorter periods have not yet been proven sufficient for evaluation.

As an additional basis for comparison, the use of the mode commends itself. This measure, which is the period at which 50 per cent survival occurs, has several definite advantages. It is a single number, which renders comparison easy. It is easily calculated, and requires a comparatively short follow-up. It commends itself to those not statistically minded as a sort of average, and is consequently easy to comprehend. Its chief statistical disadvantage, its inability to fit into further mathematical treatment, is of little importance in this work, particularly as the accompanying survival curve should give any statistician enough material to calculate such other measures as he desires.

The question of lost cases is always one of great difficulty. Theoretically, it invalidates a series to have any lost cases, nor is there any possible method of making a valid correction. The fact that such cases, far from being a simple sample of the data, are a badly biased group, makes the use of the usual statistical measures of reliability quite inaccurate, and this fact clinches the necessity of adequate follow-up in all cancer research. In practice, since we seldom attain this degree of perfection, it is probably not too great an error to assume that the lost cases are a simple sample of the group, behaving in the same fashion as those followed if—and only if—the percentage lost is small, perhaps less than 10 per cent. If the percentage is over this, it is advantageous to present two survival curves, one based on the assumption mentioned and another on the assumption that all lost patients died shortly after their last visit (Figs. 5 and 6). Since these two curves would represent the best likely and the worst possible results, one might say with some confidence that

the true curve did, in fact, lie somewhere between them. To take a concrete example, suppose that of 100 cases we succeeded in following 90 for a period of three years. Let us further suppose that of the 90 followed, 20 are living and 70 dead. On the first assumption, the three-year ordinate would be 20/90, or 22.2 per cent; while on the second it is 20/100, or 20 per cent, a difference of 2.2. per cent, which is particularly insignificant when one considers that the standard deviation of the percentage is about 4 per cent. The best possible result, if all the lost cases were living, is probably of little importance, but even that is not significantly different in this example, being only 7.8 per cent higher.

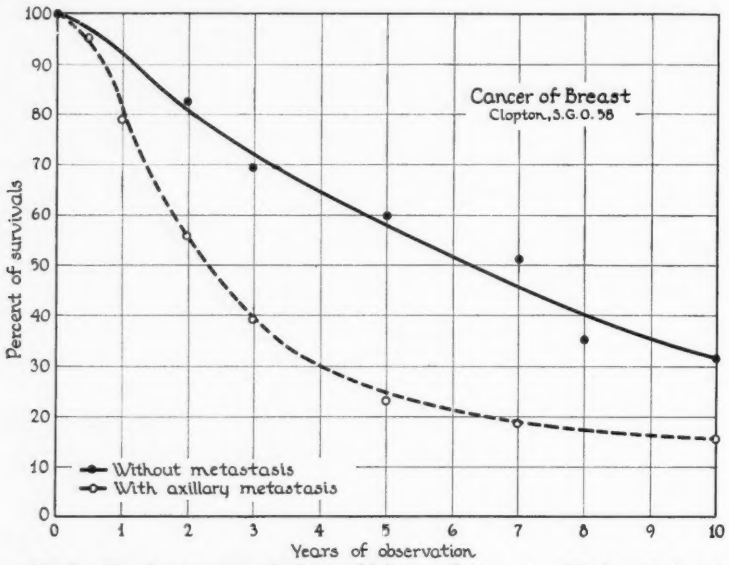

Fig. 8. Showing a very marked case of failure to flatten out. The irregularity of the curve throws some question on its validity.

It is difficult to allow properly for patients dying of causes other than cancer. For comparison, probably the simplest way is to construct an artificial survival curve based on the average probability of survival for the group for two or three points covering the range of the data (since the curve is quite smooth, not more than three points will be needed). In most series this curve will drop little from the 100 per cent line, so that no significant correction is shown; but a series composed largely of patients over 50 years of age would show a significant fall (Fig. 2). Figure 7 shows graphically the probability of survival for five and ten years at various ages, based on the "British Offices Mortality."

Of course, all the difficulties are not entirely removed, and a certain amount of extra work is involved. The initial portion of the survival curve tends to be overemphasized by the casual reader because of its larger bulk. The reliability of each point is lessened by the age variations of patients in the group. Comparisons between curves are only valid if the same general type of neoplasm is represented. Statistical measure of the accuracy of the points determined is lacking, or at least rather unreliable, because of the peculiar distributions involved. Deaths not due to cancer are only discounted in a large series.

But even in the face of these difficulties, this measure of results provides a fuller and more accurate statement than any current method; this is even plainer when one

notices that every death is considered at approximately the time it occurs, which must afford a truer picture than consideration of the number surviving any arbitrary limit. The survival curve with the adjuncts suggested is so manifestly superior to the five-year cure rate that its use should be universally adopted.

SUMMARY

It is proposed to use survival curves and modal survival as a measure of results in treating cancer, in place of the five-year cure rate. Certain adjuncts are suggested, the advantages pointed out, and the difficulties briefly discussed.

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AIR IN THE HEPATIC DUCTS: AN X-RAY SIGN OF BILIARY FISTULA[1]

By ROBERT A. POWERS, M.D., *Palo Alto, California*

SPONTANEOUS biliary fistulæ are probably not as rare as is generally supposed. Before the advent of the roentgen ray, clinical diagnosis of this condition was rarely made. Moller (1), quoted by G. A. Moore, states that out of 22 cases of gallstone ileus which he operated upon, the correct diagnosis was made in three cases. Courvoisier (2) states that about 4 per cent of his cases of intestinal obstruction from all causes were due to gallstones. Powers (3) found four cases, or 2.2 per cent, in 179 operations for intestinal obstruction. Kehr (4) found 100 fistulæ, or about 5 per cent, in 2,000 gall-bladder operations.

Since roentgen-ray examinations have come into general use, diagnoses of biliary fistulæ have been more frequent. In 1933, Firor (5) collected 40 odd cases from the roentgen literature. As the writer has seen four cases in one small hospital, there appears to be no question but that many times this number have been unreported. Firor credits Busic with having made the first roentgen diagnosis in 1919. In 1920, Carman (6) reported a case in which a pyloric carcinoma had ulcerated into the gall bladder: barium found its way into the hepatic ducts. In 1925, Havlicek (7) reported a case and stated that the condition had not been previously described. In 1933, Lucas Henry (8) reported a beautifully illustrated case in which the bile ducts were outlined first by air and then by barium.

Fig. 1-*A*.

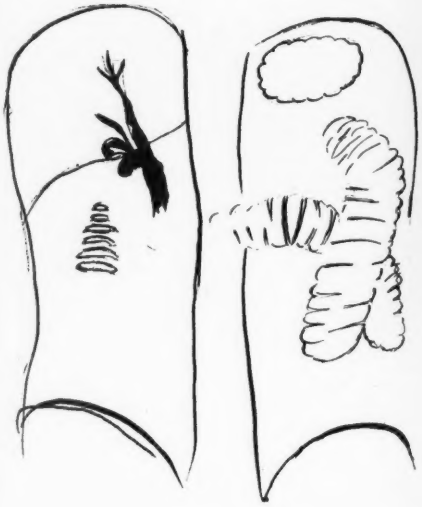

Fig. 1-*B*.

Fig. 1-*A*. Case 1. Acute gall-bladder fistula—pneumocholedochus—gallstone ileus. Note branched tubular air shadows in hepatic ducts; also dilated jejunum. The calculus as seen in Figure 1-*C* was opaque but not visible on this film. An ileostomy was performed, with complete recovery.

Fig. 1-*B*. Case 1. Diagrammatic representation of the foregoing (*cf.* Fig. 1-*A*).

Biliary fistulæ are usually due to the

[1] Read before the Radiology Section of the California Medical Association, at the sixty-fourth Annual Session, Yosemite National Park, May 13–16, 1935.

erosion or ulceration of large gallstones, but may result from benign or malignant ulcerations and may originate in either the gastro-intestinal or biliary tracts; duodeno-biliary fistulæ are by far the most common. In the 40-odd cases collected by Firor, 36 were duodeno-biliary fistulæ; four biliary colic fistulæ; two hepato-bronchial fistulæ, and one gastro-biliary fistula. Von Schlapfer (9) states that in one case a stone was expelled in the vomitus and a gastro-biliary fistula was subsequently found. Fistulæ have also been reported between the gall bladder and kidney and the gall bladder and the urinary bladder (10). One case is said to have voided 200 stones in the urine.

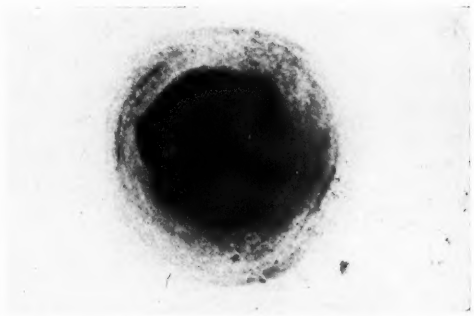

Fig. 1-*C*. Case 1. The gallstone producing the rupture and intestinal obstruction was not visible on the original film. Its failure to cast a shadow was not due to insufficient calcium as demonstrated on this film taken following its removal. It must have been below the area filmed.

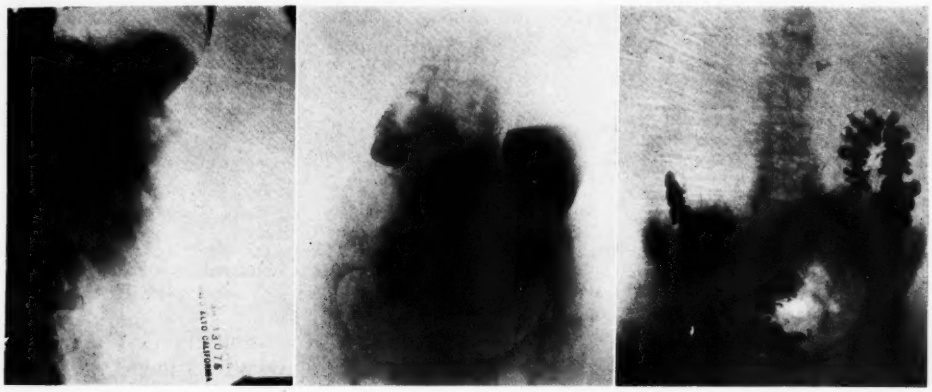

Fig. 2-*A*. Fig. 2-*B*. Fig. 2-*C*.

Fig. 2-*A*. Case 2. Pneumocholedochus; tubular air shadow in hepatic duct. This shadow should rarely be confused, and practically always indicates an anastomosis between the biliary tract and some portion of the intestinal tract, usually the duodenum.

Fig. 2-*B*. Case 2. Pneumocholedochus. The barium is seen entering an elongated viscus superior to the duodenal bulb. This was thought to be the gall bladder containing a solitary negative calculus. At operation, it proved to be a greatly dilated common bile duct containing a stone. A large diverticulum is seen in the second portion of the duodenum.

Fig. 2-*C*. Case 2. Pneumocholedochus (24 hours). The common bile duct still retained barium while the upper gastro-intestinal tract was empty.

Roentgen findings in biliary fistula may be air or barium in the hepatic ducts or a large solitary calculus with a facet. Air in the bile ducts must be a common finding as it was present in three of the four cases observed by the writer. Air shadows are usually tubular or branched, and follow the general direction of the common duct. Air may surround a calculus in the gall bladder and cause a crescentic shadow.

Upon two occasions the writer has observed tubular transparent shadows arising near the spine and extending downward from left to right. I can find no adequate explanation of these pseudo-air shadows. They may be due to fat in the ligamentum teres hepatis. One of these cases was operated upon for a perforating duodenal ulcer and no fistula was present.

Air or barium rarely enters the hepatic ducts except through a biliary fistula. Not infrequently one sees the opening of the

Fig. 3-*A*.

Fig. 3-*B*.

Pneumocholedochus with intestinal obstruction. Note the small crescentic tubular region. This is undoubtedly air in the gall bladder, apparently partially surdilated small bowel can be seen below. Diagnosis was confirmed at operation.
te spasm of the lower two-thirds of the stomach in case of pneumocholedochus. re of relaxation when examined one hour later.

Fig. 3-*C*. Case 3. Diagrammatic sketch of the
bladder.

infiltration, the ampulla may be gaping open, but to my best knowledge no such authenticated cases have been recorded.

Case 1. The first case observed by the writer, Mrs. J. C., was admitted to the Palo Alto Hospital on July 27, 1932. The attending physician stated that there had been at least two previous attacks of severe abdominal pain. Three days before admission the patient was seized with a severe attack of pain, nausea, and vomiting. This continued until admission, when the picture was that of intestinal obstruction. A flat abdominal film showed markedly distended coils of jejunum and the hepatic ducts beautifully outlined by air. At operation, a stone 4 cm. in diameter was removed from the jejunum. The gall bladder was firmly adherent to the duodenum and, owing to the patient's condition, could not be freed. The woman made an uneventful recovery.

Case 2. One week following the pre-

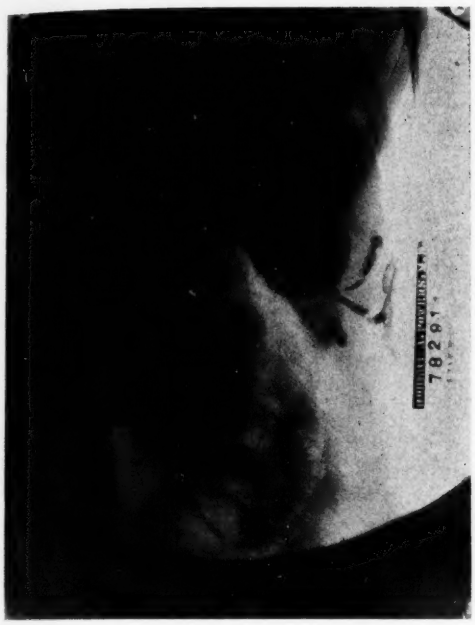

Fig. 4-*A*.

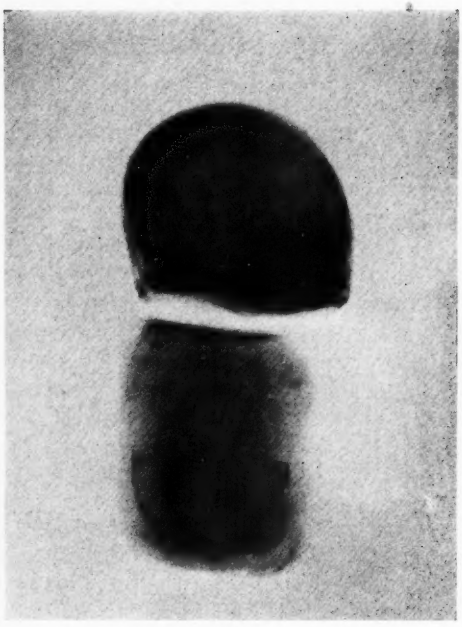

Fig. 4-*B*.

Fig. 4-*A*. Case 4. Spontaneous duodenocholecystostomy. An enormous stone is present in the gall bladder. One side of the stone is flattened, suggesting friction against another stone, of which there is no evidence. An inferential conclusion of spontaneous duodenocholecystostomy was made. The second stone was found in the small bowel.

Fig. 4-*B*. Case 4. Spontaneous duodenocholecystostomy. The upper stone was removed from the small intestine, the lower one from the gall bladder. There is an interesting difference in the calcium content of the two calculi.

vious case, Mrs. J. J. B. was sent to the hospital for clinical study. The patient had complained of sub-sternal pain of six months' duration, which was intermittent, lasting several days and then going away for a time. It had been quite intense for three weeks, and sometimes radiated behind the left shoulder. She had chills and a temperature of 100 degrees F. She was always nauseated, and vomited by forcing herself. She had lost 25 pounds in weight. Three years previously she had been operated upon for appendicitis. A plain gall-bladder film showed a tubular air shadow extending up into the hepatic area. On barium meal examination, the barium was seen to extend up from the junction of the first and second portions of the duodenum, apparently into the gall bladder. A translucent area suggested a cholesterin stone. There was a large diverticulum arising from the second portion of the duodenum. At 6 and 24 hours, the supraduodenal pouch still retained barium.

At operation there was found a marked hepatitis. The pancreas was also swollen. The gall bladder had shrunk until it was 1.5 cm. in diameter and 2 cm. long. The cystic duct was atrophic. The common duct was 2.5 cm. in diameter, swollen, and contained a calculus 2 cm. long and 1.5 cm. in diameter. A fistula extended between the common duct and the duodenum. There was also a very small closed fistula between the common duct and the gall bladder. At operation, the fistula into the duodenum was closed, the common duct opened, and the stone removed. The gall bladder was removed, a tube inserted into the common duct for drainage, and a cigarette drain to Morison's pouch. The patient had a stormy convalescence, drain-

ing bile for several weeks. She left the hospital on Sept. 24, 1932, in fairly good condition.

Having observed hepatic air shadows in two cases in a single week, the writer looked up a case which had been examined several years previously. This patient, Mrs. A. C., had been admitted to the Palo Alto Hospital, May 7, 1923. A rather meager history stated that there had been vomiting for a week. Roentgen examination showed a marked narrowing of the entire stomach with the exception of the cardiac pouch. At 6 hours typical dilated coils of jejunum were observed. Roentgen diagnosis was intestinal obstruction.

A review of the films in this case shows a definite air shadow in the hepatic area. The air appears to be surrounding a cholesterin calculus. At operation, a large stone was removed from the intestine and another from the gall bladder; a fistula was found to be present between the gall bladder and the duodenum. The gall bladder was removed and the fistula closed. After an uncertain period of five weeks the patient was discharged in fairly good condition.

Air shadows in the hepatic tree probably occur quite frequently and, as many of these patients are too ill for the administration of barium, the air finding is probably of more clinical value.

Case 4. A fourth case, Mrs. J. C., was examined as an office patient on July 8, 1929. This patient, a Christian Scientist, had been ill for several days with nausea, vomiting, and pain in the right upper abdomen. Films of the gall-bladder area showed a large calculus 3.5 cm. in diameter, the lower half spherical while the upper margin was perfectly flat. As the large calculus was faceted and no opposing calculus was present, a roentgen diagnosis of gall-bladder perforation was made. Being a Scientist, the patient temporized for three days, following which she was operated upon, although in a rather critical condition. A large stone was removed from the lower ileum and another from the gall bladder. A fistula between the gall bladder and duodenum was closed and the gall bladder removed. As is usually the case with delayed intestinal obstruction operations, the patient died.

I have found no previous mention of a solitary faceted gall-bladder calculus being the basis for a diagnosis of biliary fistula. Such a diagnosis appears almost foolproof, but it is possible that one stone might have a high calcium content and the other be almost pure cholesterin. In the case described above there was a minimum of calcium in the missing stone.

In intestinal obstruction cases, careful search should always be made for air shadows. If it is true that over 2 per cent of these cases are due to gallstones, it is remarkable that this observation is not more frequently made.

SUMMARY

In closing, I wish to emphasize the following points:

Internal biliary fistulæ are probably much more prevalent than is generally believed.

In every case of intestinal obstruction, the hepatic area should be carefully searched for extra-intestinal air shadows.

A large solitary gall-bladder calculus having a facet usually means perforation.

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PORPHYRINEMIA AND PORPHYRINURIA: A WARNING REGARDING THEIR IMPORTANCE IN ROENTGEN THERAPY

By I. S. TROSTLER, M.D., F.A.C.R., F.A.C.P., *Chicago*

HOW many radiologists recognize the importance of porphyrinemia and porphyrinuria and the possible source of danger in the sensitization, by means of drugs, of the tissues to light? How many of you have had your attention called to this subject at any time?

Because of the rather recent introduction of hematoporphyrin (commercially known as Photodyne and other names) into general use in medical therapeutics, particularly in neuropsychiatry in the treatment of melancholia and allied depressive conditions, and the *decidedly too promiscuous taking and prescribing of barbituric acid derivatives as sleeping powders*, it is altogether likely that some radiologists may have reason to wonder why erythemas appear after moderate or even mild dosage.

I am calling your attention to this subject because I have had that experience myself and have been called to help another radiologist who had a scare because of the same thing.

As the result of a series of experiments with hematoporphyrin, to determine its photobiologic properties and effects, Hausman[1] reported, in 1916, that by hypodermatically injecting solutions of that agent, white mice, rats, and guinea pigs were rendered so highly sensitive to light that when they were exposed to it they became toxic and died; but when these same injected (control) animals were kept in the dark they were apparently unaffected.

Huehnerfeld[2] and others later reported that while animals so treated showed marked photodynamic effects when the hematoporphyrin was injected under their skin, no such effects resulted when the drug was administered orally, except when large doses were given. Rats fed with large doses became toxic and died within three or four hours after being exposed to bright sunlight. These rats showed fatty degeneration of central liver lobules, *hyperemia of the skin* and other pathology.

Meyer-Betz,[3] while experimenting with hematoporphyrin, administered 0.2 gm. under his own skin and then irradiated an area on his arm with a Finsen lamp, with a resulting ulceration in the irradiated area. Two months later he suffered a "light stroke," with the production of giant edema and deep pigmentation of the skin.

While the literature of the manufacturers of hematoporphyrin claims that this drug has no harmful effects, the proven fact that it sensitizes (and causes a sensitization) to light makes it very much worth our while to keep it in mind, because of the potential danger to our patients.

What appears to be more important to us as radiologists is that in addition to hematoporphyrin, many commonly used sedatives, such as sulphonal, luminol, and other barbituric acid derivatives produce porphyrinemia and porphrynuria, with the resultant sensitization to light and irradiation. These agents also cause itching, which occuring simultaneously with and accompanying skin redness is decidedly liable to give the unwary radiologist unpleasant insomnia and additional gray hairs.

I have seen three cases of what were to all external appearances roentgen erythema, one of which had been diagnosed as "x-ray burn" by a dermatologist, all of which were the result of the patients taking "sleeping medicine," at the same time that they were receiving roentgen therapy.

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None of these cases recurred when the barbiturates were discontinued, even though the dosage of the roentgen rays was increased in two of the cases. I reported two of these in a communication to the "Journal of the American Medical Association" last April.[4] The third case is still under my observation, and is as follows:

A blonde woman of 30, while receiving roentgen treatment to relieve thyrotoxicosis, developed a definite redness over the treated area, one week after the application of 160 r delivered at 130 p.kv. through 3 mm. aluminium. Inquiry from the physician who referred her disclosed the fact that she was taking luminol elixir in moderate dosage for her nervousness. This was immediately stopped and quinine hydrobromid substituted. After the erythema had subsided, I administered 200 r and later continued the treatment with 260 r without any indication of over-dosage.

My attention was first called to this sensitization by the barbiturates while searching for a line of defense in a malpractice suit which resulted from a roentgen dermatitis, and like many of the lessons learned in that manner, it came to the surface of what little intelligence I possess and presented itself when most liable to be needed.

Because of this, I am suggesting that all who do any radiation therapy remember that these drugs produce porphyrinemia and porphyrineria, which, in turn, cause the tissues to be highly sensitive to irradiation.

[4] Barbiturates and Irradiation. Jour. Am. Med. Assn., May 2, 1936, **109**, 1588.

WHAT IS THE BEST WAY IN WHICH TO TREAT BREAST CANCER?

By GENTZ PERRY, M.D., *Evanston, Illinois*

ON Sept. 2, 1935, I sent to the Diplomats of the American Board of Radiology, to a number of other prominent radiologists and surgeons, and to a considerable number of prominent physicians in general practice, 925 reprints of a paper entitled "X-ray and Radium Treatment of Cancer of the Breast,"[1] which I had read before the Illinois State Medical Society at Springfield, May 16, 1934. With each reprint I sent a letter in which I requested each physician receiving the reprint to answer certain questions and, in his reply, to state his viewpoint upon what he considers to be the best general means of treating breast cancer. Many interesting and instructive letters have been received in response from the physicians.

It is the purpose of this paper to make as careful and complete an analysis of these replies as a limited space will permit. A majority of the radiologists express themselves as being in accord with the ideas and propositions set forth in the reprints and letter, as to the technic and value of radiation therapy. They vary widely, however, in their views concerning the follow-up surgical care. On the other hand, a minority of the surgeons who have replied are in favor of the plan of treating cancer of the breast as outlined in the reprints. A majority of them state that they believe the complete removal of the breast and axillary lymphatic tissues to be the best means of getting rid of breast cancer. The replies received from internists and from physicians in general practice show a great majority of these latter groups to be in favor of the propositions set forth in the reprint, especially the plan and technic of thorough pre-operative radiation therapy.

The three basic propositions set forth in the reprint alluded to are:

Proposition 1.—A dosage of at least 5,000 r, in air, in some cases more than this, delivered from an x-ray tube activated by a current of 200 kv. or more potential,

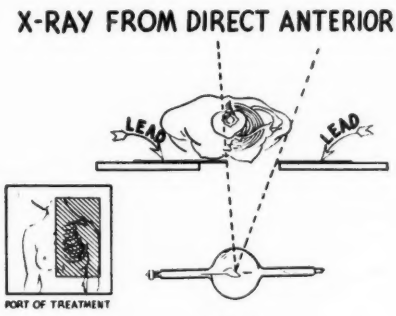

Fig. 1.

which x-ray passes through a filter of 2 mm. Cu or its equivalent, the secondary radiation from this filter being absorbed by proper aluminum or other filters, and the whole dosage delivered by the cross-fire method through five portals of entry, as illustrated by the accompanying sketches. This radiation is to be delivered within a period of from two to four weeks, or as rapidly as may be done without causing a pronounced roentgen sickness (nausea, etc.) during the treatments, and without producing a too pronounced leukopenia or anemia.

These sketches, which show precisely how this dosage is delivered to a patient resting upon a standard treatment couch, from the x-ray tube in the couch under the patient, in all of the positions for treatment except the position for the doses of x-ray delivered directly downward through the top of the shoulder and base of the neck on the affected side, while the patient is sitting in an upright position (which doses are delivered to the patient from an overhead tube), are published with the hope of clarifying the general propositions. These are that the main portions of the x-ray doses are given through the breast, chest wall,

[1] Ill. St. Med. Jour., February, 1935, **67**, 129–133.

X-RAY THROUGH SHOULDER, ETC., FROM ABOVE

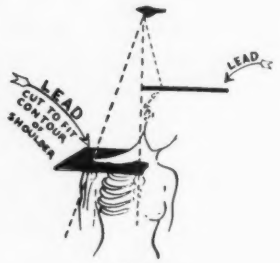

Fig. 2.

X-RAY THROUGH POSTERIOR PORT

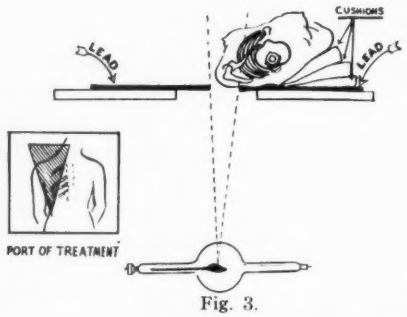

Fig. 3.

and shoulder only, and in such position as to be tangential to the ribs under the areas treated, and that only about one-fifth of the entire dosage is sent directly through the entire chest of the affected side, including the mediastinum. In the average ordinary case, we give 500 r, usually in three doses, to the patient when she is in the position shown in Figure 1.

In three or four doses, 600 r are given to the patient from the position shown in Figure 2.

At least 2,000 r is given to the patient when placed as shown in Figure 3, and in this position we aim to have the treatment aperture so arranged that these x-ray doses given from the posterior port go through the base of the neck, the entire shoulder, and the entire chest wall down to the waistline. The average patient will be nauseated if more than 180 r is given in each dose to this large area.

In doses of 200 r each, 1,000 r or more are given to the patient when in the position shown in Figure 4.

In doses of 200 r each, 1,000 r or more are given to the patient when in the position shown in Figure 5.

Ordinarily, the doses of x-ray are alternated regularly through the different fields in the sequence of their numbers. Usually the first vesication will appear upon the skin of the axilla. In the average case treated, this vesication will be rather general over the entire front chest wall, shoulder, etc., in from six to fourteen days after the treatments are finished. These blistered areas are treated by soft linen sterile pads of several thicknesses, kept constantly moist with a 2 per cent magnesium sulphate solution in distilled water, for a period of ten days. The pads are changed frequently enough to absorb all of the serum exudate from the inflamed surfaces. Following these moist pad dressings, all of the affected skin areas are sprayed twice daily by means of a strong atomizer, or by a nebulizer, with a mixture of equal parts of 01. Ricini and 01. Olivæ, and the entire surface is then covered with a light, sterile, soft linen cloth loosely fastened about the chest. The incision lines of the immediate follow-up surgery are usually covered by strips about two inches wide of several thicknesses of plain sterile gauze, or such other gauze as the surgeon may prefer, and these two-inch strips of dressing are changed rather frequently in order that they may be renewed as soon as they have become partially saturated from the serum exuding from the vesicated areas.

These same measures may be accomplished with practically any treatment apparatus, provided sufficiently thick lead shields are so placed as to bisect the central rays coming from the tube and shielding the portions of the patient's body that should not receive the x-rays. The anatomical variations of the patients and the location and extent of the cancer make it necessary to vary the relative positions of the patient, the lead shield, and the tube to

X-RAY THROUGH EXTERNAL LATERAL PORT

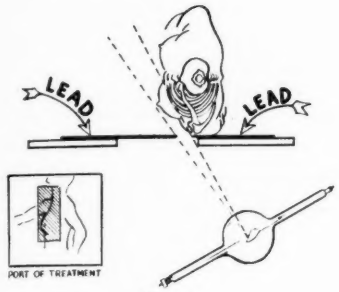

Fig. 4.

X-RAY THROUGH FRONT DIAGONAL PORT

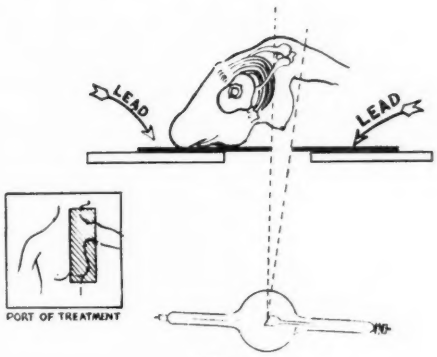

Fig. 5.

some extent, but the basic proposition that but one-fifth of the total x-ray dosage is sent directly through the lung of the affected side is, and should be, followed in all cases in which proper x-ray films show the lungs to be free from visible metastases.

Proposition 2.—The interstitial use of highly filtered, or screened, radium placed within, or through, any remaining hard cancer masses that may exist immediately after the finish of the x-ray series of treatments, it being fully understood that the use or non-use of radium in each individual case be left entirely to the discretion of the radiologist.

Proposition 3.—Surgical removal of the diseased breast *immediately* after the radiation therapy has been finished. A further point was stressed in the reprints that, unless there are remaining hard and plainly palpable masses in the axilla of the affected side, no surgical invasion of the axilla is to be done; that we are to rely entirely upon the radiation therapy to sterilize the axilla, clavicular regions, etc., from malignancy.

Classifying the replies mathematically, we have the following: There were 391 replies up to May 5, 1936; 192 of these letters are from radiologists, 79 are from surgeons, and the remaining 120 are from physicians in general practice, internists, etc.

Of the radiologists, 31, or 16 per cent of those from whom we have received letters, agree almost entirely with the propositions set forth in the reprints that we mailed to them. Twenty-eight per cent of the radiologists favor the same radiation therapy but differ as to the time of doing the follow-up surgery. Thirty per cent favor the use of x-ray only and nothing else. Twenty-four per cent of the radiologists prefer the use of lower voltage and smaller dosage. Two per cent favor the use of radium only.

Of the surgeons, 40 per cent are in favor of pre-operative x-ray treatment. Eighteen per cent are in favor of both pre-operative and post-operative treatment. Thirty-one per cent are in favor of surgical operation first, to be followed by x-ray treatment. Two per cent favor radium treatment first, to be followed by operation. One surgeon writes that he is not in favor of any radiation therapy unless a recurrence follows the operation, and then he advises the use of radium only. About 8 per cent of the surgeons expressing themselves apparently have no confidence whatever in radiation therapy of any kind at any time.

From the physicians in general practice, internists, etc., we have 120 letters showing that 72 per cent are in favor of pre-operative radiation therapy to be followed by surgical operation, and about one-fifth of these same physicians express themselves as being in favor of post-operative radiation therapy also. Eight per cent of these last-named physicians favor surgery first, to be

followed up by x-ray treatment. Eleven per cent express their preference for surgical treatment only and are not in favor of any radiation therapy at any time. Nine per cent are in favor of treatment of breast cancer solely by x-ray.

There is only one point upon which all of the letters agree 100 per cent insofar as they express themselves on this point, and that is that the earlier these cases are seen and properly treated according to their own viewpoints, the better is the chance for successful eradication of the disease. The general impression one gets from a careful study of these letters is that the treatment of breast cancer is receiving an increasing amount of careful study and attention from the medical profession. Many of the letters clearly express important facts relative to the age and physical conditions of the patient as these factors influence the prognosis in each case. A further significant fact brought out in the study of these letters is that the first-named group of 31 radiologists who, for the most part, fully agree on the pre-operative radiation treatment producing marked skin reactions as set forth above, embrace some of our most successful radiation therapists. However, very few have mentioned any surgical technic. Of course, we leave the surgical technic to the surgeon.

A question that arises in the study of these cases is whether or not the timid use of insufficient dosage by some radiologists may not constitute one of the causes why the other members of the medical profession are more or less skeptical about the value of radiation therapy. In this matter of proper dosage, permit me to quote the following paragraph from the extremely interesting and practical editorial by Dr. George W. Grier in the April number of RADIOLOGY:

> "Incidentally, I might mention that Coutard treatment always produces what is commonly called an x-ray burn, with blistering and ulceration of the skin. This is a necessary part of the treatment and results cannot be obtained without it. Yet in some of our States the courts still hold that the presence of an 'x-ray burn' is *prima facie* evidence of neglect."

Permit me to take this opportunity heartily to endorse the editorial by Dr. Orville N. Meland, "Should the Patient be Told?" which appeared in the December, 1934, number of RADIOLOGY. I believe that every normal-minded patient should be informed exactly as to the nature of the condition before the treatments begin.

636 Church Street

CALCIFIED MESENTERIC LYMPH NODES: THEIR INCIDENCE AND SIGNIFICANCE IN ROUTINE ROENTGEN EXAMINATION OF THE GASTRO-INTESTINAL TRACT

By SAMUEL SCHECHTER, M.D., *New York City*

INTRODUCTION

THE presence of calcified mesenteric lymph nodes is frequently noted in the course of roentgen examination of the gastro-intestinal tract. The relationship of these nodes to the symptomatology in these cases is often not clearly ascertained. This relationship is the object of this study.

MATERIAL AND INCIDENCE

For a number of years I assisted Dr. John L. Kantor in a series of "Colon Studies," which were published in a series of papers in the "American Journal of Roentgenology and Radium Therapy," from 1926 to 1934. The material collected for these studies (routine roentgen gastro-intestinal surveys) was also utilized for this present paper. A total of 2,119 cases was reviewed, from which were culled 35 cases in which calcified mesenteric lymph nodes were demonstrated roentgenographically (an incidence of 1.7 per cent).

It is interesting to compare these figures with the incidence of calcified nodes observed in radiographs of the lumbosacral spine and of the urinary tract. Through the kindness of Dr. Raymond W. Lewis, roentgenologist at the Hospital for Ruptured and Crippled, New York City, I reviewed the radiographs of 1,000 consecutive cases of lumbosacral spine, and through the kindness of Dr. Ross Golden, roentgenologist at the Presbyterian Hospital Medical Center, New York City, I reviewed the radiographs of 1,000 consecutive cases of examination of the urinary tract.

The spine films were taken for purely orthopedic conditions, and the films of the urinary tract were taken for suspected calculi in the kidneys or ureters. I found an incidence of 1.9 per cent of calcified nodes in the former and 2.8 per cent in the latter.

The incidence in the entire 4,119 cases reviewed was 2.1 per cent. This is a considerably lower figure than that reported by other investigators but is close to the figures noted in autopsy material.

The incidence reported by others is as follows:

(1) Strömbeck, of Stockholm, in 1932, reviewed radiographs of 600 cases, chiefly adults, who were treated for various affections of the back and kidneys. He found calcified mesenteric nodes in from "7 to 8 per cent of the cases."

(2) Auchincloss states that Dunham found calcified mesenteric nodes in 128 children out of 1,152 (or 11 per cent) routinely x-rayed.

(3) Dunham and Smythe, of New Haven, in 1926, report that 17 per cent of 120 children with positive tuberculin tests had x-ray evidence of calcified mesenteric nodes.

In contrast to the incident findings in radiographic material, the incidence of calcified mesenteric nodes in autopsy material quoted by Golden and Reeves is as follows:

(4) Opie, of St. Louis, in 1917, reports not a single case in a series of necropsies on 93 children and 50 adults.

(5) Hof, of Kiel, Germany, in 1903, in a study of necropsies on 7,203 children and 7,683 adults, found tuberculous mesenteric

TABLE I.—SITE OF CALCIFIED NODES

Region	Level	Cases	Percentage
R. L. Q.	Third lumbar to second sacral	21	60.0
L. L. Q.	Third lumbar to second sacral	5	14.3
Periportal	Above third lumbar right	6	17.1
Midline	First sacral	2	5.7
Bilateral	Third to fifth lumbar	1	2.8
		35	99.9

lymphadenitis, with no evidence of tuberculosis elsewhere in the body, in 1.4 per cent of children and 0.8 per cent of adults.

(6) Bietzke, in the Berlin Pathological Institute, found 0.9 per cent in 1,100 necropsies.

Sex.—The cases in our study revealed only a slight difference in the sex incidence: 54.3 per cent were males and 45.7 per cent were females.

Age.—The age group distribution was as follows:

1 year to 10 years— 1 case
11 years to 20 years— 0 case
21 years to 30 years—15 cases
31 years to 40 years—10 cases
41 years to 50 years— 5 cases
51 years and over—4 cases

Sex and age incidence conform in the main to the incidence of these factors in the unselected series of gastro-intestinal cases.

SITE OF CALCIFIED NODES

In Table I is indicated the site of the calcified nodes. The preponderance of cases in which the nodes are localized in the right lower quadrant of the abdomen is in accord with the findings of other observers.

SYMPTOMATOLOGY

The symptoms presented by the 35 patients in our series were those that would

TABLE II.—SITE OF CALCIFIED NODES, LOCALIZATION OF PAIN AND TENDERNESS, AND OTHER X-RAY FINDINGS

Case	Site of Nodes	Pain	Tenderness	Other X-ray Findings
1.	R. U. Q.	Both costal margins R. L. Q.	Epigastric	Duodenal ulcer
2.	Bilateral, R. and L. L. Q.	None	None	Spastic colon; dyschezia
3.	R. L. Q.	"	R. L. Q.	Spastic colon
4.	R. L. Q.	"	"	Cecal stasis; high cecum
5.	R. U. Q.	"	L. L. Q.	Low cecum; pulm. tbc.
6.	L. L. Q.	Epigastric	L. L. Q.	Gallstones
7.	R. L. Q.	Substernal	None	None
8.	L. L. Q.	R. L. Q.	"	Diverticulosis (colon)
9.	L. L. Q.	R. L. Q.	R. U. Q.	Simple colitis
10.	R. L. Q.	None	None	None
11.	Midline, 1st sacral	"	R. L. Q.; epigastric	Nephrolithiasis; spastic and redundant colon
12.	Midline, 1st sacral	R. L. Q.	R. L. Q.	Simple colitis
13.	R. L. Q.	None	None	Ulcerative colitis
14.	R. L. Q.	R. U. Q.	R. L. Q.	Simple colitis
15.	R. L. Q.	R. L. Q.	R. L. Q.	None
16.	L. L. Q.	L. L. Q.	None	Simple colitis
17.	R. L. Q.	L. U. Q.	L. U. Q.	G. B. disease; simple colitis
18.	R. L. Q.	R. L. Q.	R. L. Q.	Simple colitis
19.	R. U. Q.	None	None	Low cecum; duodenal bands
20.	R. U. Q.	General abdominal discomfort	"	Simple colitis
21.	L. L. Q.	None	"	Low cecum
22.	R. U. Q.	"	"	Visceroptosis
23.	R. L. Q.	"	"	Low cecum
24.	R. L. Q.	Epigastric, L. L. Q.	L. L. Q.	Low cecum
25.	L. L. Q.	Navel	R. L. Q.	Simple colitis
26.	L. L. Q.	R. U. Q.	Slight, over liver	Gastro-enterostomized for D. U.
27.	R. L. Q.	Epigastric	None	Duodenal ulcer
28.	R. U. Q.	None	R. L. Q.	Low cecum; dyschezia
29.	R. L. Q.	"	L. L. Q.	Diverticulosis; simple colitis
30.	R. L. Q.	L. L. Q.	None	Redundant colon
31.	R. L. Q.	None	"	Low cecum; delayed gastric emptying
32.	R. L. Q.	"	"	Redundant colon
33.	R. L. Q.	Epigastric	R. L. Q. and L. L. Q.	Simple colitis
34.	R. L. Q.	None	Both costal margins	Simple colitis
35.	R. L. Q.	L. L. Q.	L. L. Q.	Simple colitis

suggest the advisability of a roentgen study of the gastro-intestinal tract and may be divided into two groups, local and general. The most prominent local symptoms were abdominal pain and tenderness, and the chief general symptoms were nausea and vomiting.

Abdominal pain was present in 19, or 54.3 per cent, of the cases. This is only slightly above the general incidence of abdominal pain, which is 47 per cent. A fairly marked increase was noted, however, in the incidence of right lower quadrant pain, which was present in 17 per cent of the cases and compares with a general incidence of only 9 per cent.

Abdominal tenderness was present in 18, or 51.4 per cent, of the cases. This is a marked increase when compared with the general incidence of 29.7 per cent. The incidence of right lower quadrant tenderness, however, was only 25.7 per cent against a general incidence of 19 per cent.

Nausea and vomiting were present in 15, or 42.9 per cent, of the cases, a striking increase when contrasted with a general incidence of 20 per cent.

One may conclude from the above that the cases in our series showed a somewhat increased percentage incidence of both local and general symptoms. It is, of course, appreciated that, when dealing with such a small number of cases, the figures obtained may be misleading. Therefore, as a check, a study of the other findings in the roentgen examination of these 35 cases was made. This showed that, in a large number of cases, co-existent roentgen abnormalities were present that could be considered adequate cause for these symptoms.

Table II correlates the local symptoms of abdominal pain and tenderness with the site of the calcified nodes and the presence or absence of other roentgen findings.

A summary of Table II shows the following:

10 cases, or 28.5%, with no abdominal pain or tenderness.

2 cases, or 5.7%, with abdominal pain and tenderness localized at site of nodes.

1 case, or 2.8%, with abdominal pain but no tenderness at site of nodes.

1 case, or 2.8%, with abdominal tenderness but no pain at side of nodes.

3 cases, or 8.6%, with abdominal tenderness at site of nodes but pain not at site of nodes.

5 cases, or 14.3%, with abdominal pain and associated tenderness but not at site of nodes.

3 cases, or 8.6%, with abdominal pain and tenderness differently localized and not at site of nodes.

5 cases, or 14.3%, with abdominal pain but no tenderness and not at site of nodes.

5 cases, or 14.3%, with abdominal tenderness but no pain and not at site of nodes.

Further condensing of this table shows that in only four, or 11.4 per cent, of the cases there was localization of pain, tenderness, or both at the site of the calcified nodes. In three, or 8.6 per cent, of the cases there was abdominal tenderness at

TABLE III

Case	Site of Nodes	Nausea or Vomiting	Other X-ray Findings
2.	Bilateral, R. and L. L. Q.	Nausea	Spastic colon; dyschezia
5.	R. U. Q.	Vomiting	Low cecum; pulm. tbc.
7.	R. L. Q.	Vomiting	None
9.	L. L. Q.	Nausea and vomiting	Simple colitis
10.	R. L. Q.	Vomiting	None
11.	Midline, first sacral	Nausea and vomiting	Nephrolithiasis; spastic and redundant colon
12.	Midline, first sacral	Vomiting	Simple colitis
14.	R. L. Q.	Nausea	Simple colitis
15.	R. L. Q.	Vomiting	None
16.	L. L. Q.	Vomiting	Simple colitis
17.	R. L. Q.	Vomiting	Gall-bladder disease; simple colitis
26.	L. L. Q.	Nausea	Gastro-enterostomized for D. U.
27.	R. L. Q.	Vomiting	Duodenal ulcer
31.	R. L. Q.	Nausea and vomiting	Delayed gastric emptying; low cecum
34.	R. L. Q.	Nausea	Simple colitis

the site of the nodes but pain elsewhere. In the remaining 28, or 80 per cent, of the cases, pain and tenderness were either absent or not localized at the site of the calcified nodes. Of the four cases with pain or tenderness at the site of the nodes, only one had no other roentgen abnormality than the calcified nodes. This case was operated upon and the calcified nodes removed.

Of the 18 cases in which abdominal pain, tenderness, or both were present but not localized at the site of the calcified nodes, all but three cases revealed adequate cause for the presence of these symptoms.

The symptoms of nausea and vomiting were similarly analyzed. Table III correlates these general symptoms with the site of calcified nodes and the presence or absence of other roentgen findings.

A summary of Table III shows that in only three, or 20 per cent, of the cases in which nausea, vomiting, or both were present, were any other roentgen abnormalities found, whereas in 12, or 80 per cent, of the cases other roentgen findings were noted that may be considered adequate cause for their presence. One of the three cases was the previously mentioned case that was operated upon and was found to have localization of pain and tenderness at the site of the calcified nodes. The other two were cases of gastro-intestinal neuroses.

These statistical symptom analyses suggest that the following conclusion may be drawn: *viz.*, abdominal pain and tenderness, which are considered outstanding symptoms in the clinical evidence of calcified mesenteric lymph nodes, do not bear this symptom relationship when these nodes are found in routine roentgen studies of the gastro-intestinal tract. The same conclusion seems to be warranted in regard to the general symptoms of nausea and vomiting.

This conclusion is somewhat supported by the follow-up evidence. After institution of medical treatment, a follow-up of the 25 patients who complained of abdominal pain and tenderness revealed the following, in periods ranging in some cases from as short a time as three months, to one as long as eight years:

	Cases
Improved	13
Unimproved	2
No follow-up data	9
Died following septic meningitis	1
	25

In one case the follow-up revealed an increase in size of the node calcification. It measured $^{3}/_{16}$ of an inch in diameter at the first examination and $^{5}/_{16}$ of an inch six years later. This node was present in the periportal region in a case of duodenal ulcer. The two unimproved cases were followed up for only a very short time and then were lost track of.

TABLE IV.—APPENDECTOMY IN CALCIFIED MESENTERIC LYMPH NODE CASES

Appendectomy	11 cases,	or 31.4%	(general incidence, 17%)
Clean cases	9 "	or 8.8%	
Pus cases	2 "	or 18.2%	(general incidence, 16%)

APPENDECTOMY

As might be expected, in view of the high incidence of right lower quadrant pain, 17 per cent (general incidence, 9 per cent), and the high incidence of nausea and vomiting, 42.9 per cent (general incidence, 20 per cent), a large percentage of the cases in our series was appendectomized. In all the cases the operation was performed prior to our roentgen study of the gastro-intestinal tract. Though the incidence of appendectomy is markedly increased, the percentage of pus cases is almost exactly the same as that of the general incidence as shown in Table IV.

SUMMARY

(1) Calcified mesenteric lymph nodes were found in 1.7 per cent of 2,119 routine gastro-intestinal roentgen surveys.

(2) Comparative incidence findings are 1.9 per cent in 1,000 consecutive cases of lumbosacral spine radiographs, and 2.8 per

cent in 1,000 consecutive cases of urinary tract radiographs.

(3) In 60 per cent of the cases the site of the calcified nodes was in the right lower quadrant of the abdomen.

(4) An increased percentage incidence of both local and general symptoms is noted, but relation to calcified lymph nodes is not apparent.

(5) A large percentage of the cases, 80 per cent in this series, revealed either absence of abdominal pain and tenderness or localization of these symptoms at sites other than that of the calcified nodes. Of this number, 28.5 per cent had no abdominal pain or tenderness.

(6) Abdominal pain and tenderness, which are considered outstanding symptoms in the clinical evidence of calcified mesenteric lymph nodes, do not appear to bear this symptom relationship when these nodes are found in routine roentgen studies of the gastro-intestinal tract. The relationship to the general symptoms of nausea and vomiting is also indefinite.

(7) Appendectomy is frequently performed because of the high incidence of right lower quadrant pain and of nausea and vomiting.

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CASE REPORTS AND NEW DEVICES

A SIMPLE DEVICE FOR X-RAYING EGGS OF THE DOMESTIC FOWL

By J. M. ESSENBERG, *Chicago, Ill.*

From the Anatomical Laboratories, Loyola University School of Medicine

In x-ray work with bird eggs some sort of a device must be made in order to facilitate irradiation and eliminate experimental errors. Such construction must include a heating element for keeping eggs at incubator temperature while being irradiated; it must include a candler for orientation of eggs for general as well as local irradiation, and it must be lead-insulated in order to absorb scattered rays. Further, it must be of simple construction and permit ease in handling. Such apparatus has been constructed and used in our laboratories for the last five years with considerable advantage.

CONSTRUCTION

An ordinary wooden box of commercial design forms the framework of the device (Fig. 1). It is of medium weight, and measures approximately 7.5 in. in width, 7.5 in. in height, and 15 in. in length. The top is covered with a sheet of lead $^1/_{16}$ of an inch in thickness. At one end of the box is attached a cup-like structure while at the other is secured a wooden cross-bar. The cup is made of a lead strip, 13 in. long and $1^3/_4$ in. wide, the ends of which are soldered together, shaped into an oval measuring approximately $3^3/_4$ in. and $4^1/_2$ in. in minor and major diameters. It is, in turn, soldered to the lead sheet covering the top of the box, and placed 5 in. from the end of the box to the center of the cup with equal distances from side to side. In the center of the cup, there is cut an egg-shaped opening, $^7/_8$ by $1^1/_4$ in., through the lead and the board. The longer axis of the cup and that of the opening coincide. That part of the lead sheet immediately surrounding the opening is bent upwards $^3/_{16}$ of an inch. The cross-bar is provided with a V-shaped groove, forming an angle of 90°. The square bar of the tube carriage fits into this groove. The height of the bar plus the height of the box is such that when the carriage bar rests in the V-shaped groove of the cross-bar, it automatically determines the focal distance. The distance of the cross-bar from the lead cup is such that it will bring the mouth of the cup directly under the target of the x-ray tube.

The opening leading from the cup into the box is provided with a shutter, which is made of a lead sheet $^1/_{16}$ in. in thickness and 3 in. square. This square sheet of lead slides after the fashion of a gate-valve, in troughs provided on either side of the opening. The troughs are 6 in. long with one end closed and the other set against the board at the end of the box. At one end of the shutter, in the middle, a metal handle 4 in. long is attached. This provision enables the operator to manipulate the shutter in such a way that the opening can be completely closed or opened, as the occasion may demand.

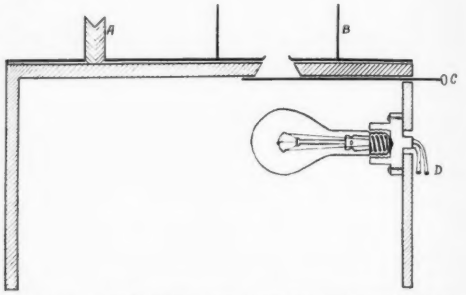

Fig. 1. Irradiation box, longitudinal-section view. *A*. Carriage rest-bar, *B*. Lead cup, *C*. Shutter, *D*. Electric light cable.

Directly in line with the opening in the bottom of the cup, and immediately below the shutter, is placed an electric light bulb. A Keyle's receptacle is attached to the end of the box, $1^1/_2$ in. below the top board. A 60-watt light bulb is used, as it is large enough to fit into the opening in the floor of the cup. A flexible cable extends through the board at the end of the box and is made long enough to facilitate connections. For convenience, two spools may be screwed on the side of the box on which the cord may be wound when not in use.

OPERATION

The light in the box is turned on a short time before radiation of the eggs. A thermometer is placed in the lead cup, and while the heating process continues, the box is placed on the x-ray machine and connected with the tube carriage. In from ten to fifteen minutes, depending upon the temperature of the room, incubation temperature is reached and radiation may proceed. During radiation the temperature is regulated by turning the light on or off, as the case may be. We have found this satisfactory, and in case greater ease is desired, a thermostat can be inserted for that purpose. The light, beside serving as a heater also serves as a candler. The egg is placed in

the cup, the shutter removed, and as the light is turned on, abnormalities in incubation can be detected readily. After candling, the eggs (three in number) are placed on the ledge of the cup, then the opening is closed by the lead shutter, and the eggs are irradiated. Thus the entire cup is made of lead which absorbs scattered rays and prevents the formation of secondary rays. In case local irradiation is desired, a piece of lead sheet with an opening in it to suit the purpose in view is placed on top of the cup; the candler in the box is used and, while looking through the opening in the top lead sheet, the places desired for radiation can be located. By this method the entire embryo is shielded except the spot to be exposed to the x-ray.

AN INTRAMUSCULAR LIPOMA

CASE REPORT

By SAMUEL BROWN, M.D., *and* AARON GROLLMAN, M.D., *Cincinnati, Ohio*

Among the first to make a pre-operative roentgenologic diagnosis of a lipoma is Nicolas Tagliavacche (1), who describes a case of a subaponeurotic encapsulated fibrolipoma situated in the deltoid muscle. The author credits Bufalini with having called attention to the transparency of a lipoma in relation to the muscle tissue surrounding it, which results in a clear delimitation of the tumor. Another case is reported by P. Benini (2). The tumor was located in the region of the right lower ribs. The roentgenogram showed a sharply defined area of decreased density; upon removal, the tumor proved to be a lipoma.

The case to be reported is that of a man, aged 50 years. He was referred for an x-ray examination of the right lower extremity because of a hard lump on the mid-lateral aspect of the thigh. The patient stated that he had noticed the mass about one and a half years before. It was not painful and it had not increased in size. Examination of the thigh revealed a fullness in the mid-lateral portion which appeared to be quite firm. The mass was fixed to the underlying tissue but was not attached to the skin. There was no tenderness upon pressure.

A study of the roentgenogram revealed no abnormal changes in the femur. On the external aspect of the femur there was noted an oval shaped transparent shadow within the muscle tissue from which it was sharply delimited (Fig. 1). The diagnosis of a lipomatous growth was made. The patient was operated upon by one of us (A. G.). The tumor was situated beneath the fascia lata, between the vastus lateralis and the biceps femoris, overlying the periosteum of the bone.

Fig. 1. An intramuscular lipoma

It was easily shelled out from its bed. The pathologic report was that of a lipoma.

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AN UNUSUAL CASE OF CALCIFIED BODIES IN THE MUSCULATURE OF THE ENTIRE BODY

By M. J. LESOFF, M.D., *and* S. SHULMAN, M.D., *Far Rockaway, N. Y.*

Roentgenologists, St. Joseph's Hospital

This case is reported because of the unusual and extensive radiographic findings which were discovered accidentally during the course of a routine examination.

M. C., a white female, aged 95 years, born in U. S., was admitted to the hospital because of pain in the right hip and back. She had suffered an injury to these regions about three weeks previous to her admission, and because of the persistence of pain and the development

Fig. 1. Radiograph of pelvis, showing calcified shadows distributed in the muscles of the gluteal region and upper thigh.

Fig. 2. Fig. 3.

Fig. 2. Radiograph of abdomen, showing distribution in the lumbar muscles.
Fig. 3. Radiograph of chest, showing distribution in the pectoral muscles.

of a cough it was felt advisable to send her to the hospital, although there were no definite signs of fracture. Physical examination revealed a very senile female who could not cooperate in giving information regarding either her present or past illnesses. There were no definite physical findings other than moist râles at the bases of both lungs and the changes incident to senility.

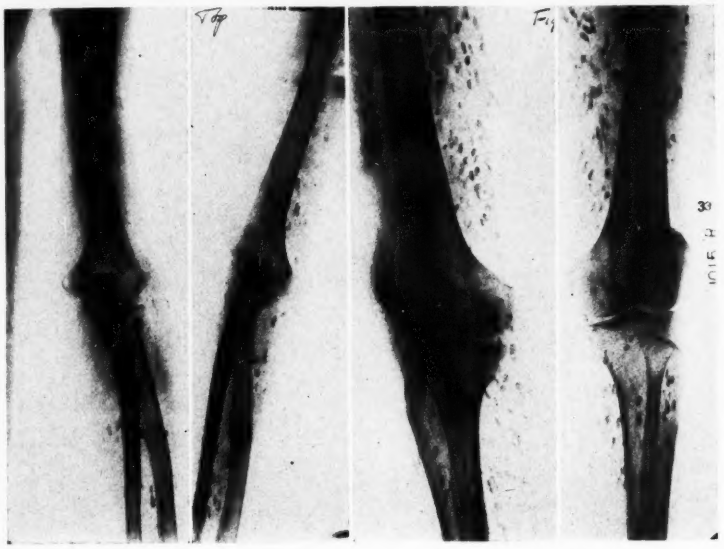

Fig. 4. Fig. 5.

Figs. 4 and 5. Radiographs of upper and lower extremities, showing distribution in the musculature.

Because of the history of trauma, she was referred to the x-ray department for an examination of the pelvis and hips. There was no evidence of fracture. There were seen to be present numerous discrete calcified shadows covering practically the entire pelvis. Additional films were them made of the chest, abdomen, and extremities, which revealed similar calcified shadows. (See Figures 1 to 5.)

Radiographic Report.—The radiographic examination of the entire body shows countless numbers of discrete calcified shadows, ovoid in shape, varying in size from one eighth to one-half inch, and with their long axes in the same plane as the part involved. They appear to be situated within the muscles. Because of their shape, size, and distribution, they probably represent some form of calcified parasites. Unfortunately, it was not possible to obtain a biopsy to ascertain the exact nature of these shadows.

COMMENT

Cases of calcified parasites in the soft tissues have been reported by Brailsford (1) and Connor (2). We were unable, however, to find a similar case involving practically all the muscles of the body. In his recent book, Brailsford mentions several parasites which undergo calcification in the muscles, and gives a brief description of their appearance. These are as follows: *Echinoccoccus, Cysticercus cellulosæ, Trichina spiralis, Dracunculus medinensis, Oncocerca, Pentastoma,* and *Sarcosporidia.* As described by him, the calcifications in our case conform more closely to that of *Cysticercus cellulosæ* than to any of the others.

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CONGENITAL NON-UNION OF THE STERNUM

By F. N. HOFFMEIER, M.D., Washington County Hospital, *Hagerstown, Maryland*

It has been my good fortune to find a congenital deformity which, so far as I am able to learn, has not been reported.

Many congenital malfusions result in no disability or loss of function and are unknown until picked up by x-ray. This was not the case with the patient in the present instance, as she knew she had "something different" and, when young, would amuse her playmates

Fig. 1. Film taken in the anterior posterior position, face down.

Fig. 2. Film taken in the oblique position, right side down.

by coughing for them. During the act of coughing her throat and upper chest distend in a spherical mass as large as an orange. This has never given her any inconvenience except for the bulging.

The patient, a female 33 years of age, was admitted to the hospital with empyema following an attack of influenzal pneumonia.

Her family history is negative—father and mother both living and well, one sister living and well, one brother died in infancy. Her personal history is essentially negative. She had the common childhood diseases except mumps and whooping-cough, and is the mother of two children.

None of the living members of her family has any deformity, but her grandmother on her mother's side told her that one of their ancestors had some deformity the exact nature of which she did not know.

The roentgenograms reproduced herewith show a congenital non-union of the sternum from the sternal notch to the level of the third rib.

MICROCOLON

TWO CASE REPORTS

By F. B. STEPHENSON, M.D., F.A.C.R.,

Denver, Colorado

Microcolon is rare; Rankin, Bargen, and Buie (1), in the 1932 edition of their book, refer to six definitely certain cases. In 1925, however, Greig (2), of Edinburgh, while reporting three cases, records a comprehensive study of the anomaly and gives statistical data derived from 28 cases. He comments on there having been found two cases in 111,451 Vienna autopsies, and nine cases in 150,000 Leningrad autopsies. The 75 references listed will furnish a complete bibliography to that date for anyone wishing to pursue the subject. The rarity of the anomaly makes it a coincidence worth noting that the following two cases were encountered within fourteen days of each other at the Children's Hospital, Denver, having been referred to the same Denver pediatrician. Both were diagnosed roentgenologically by opaque enema, and one proven by autopsy. Both showed incomplete rotation.

Case 1. J. P., white, male, patient of Dr. John A. Schoonover, was admitted to the

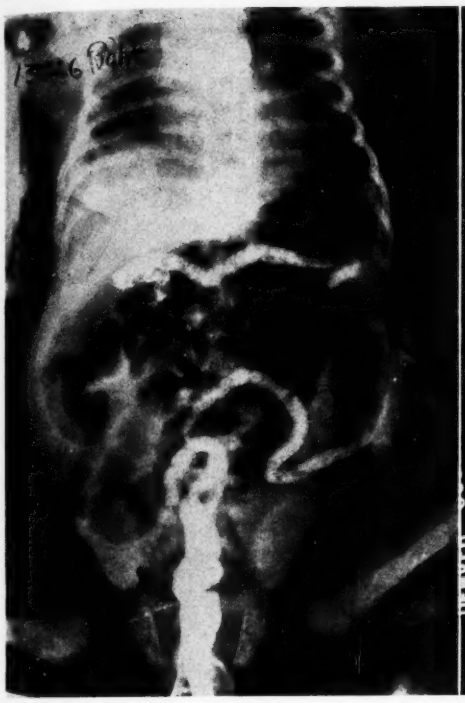

Fig. 1.

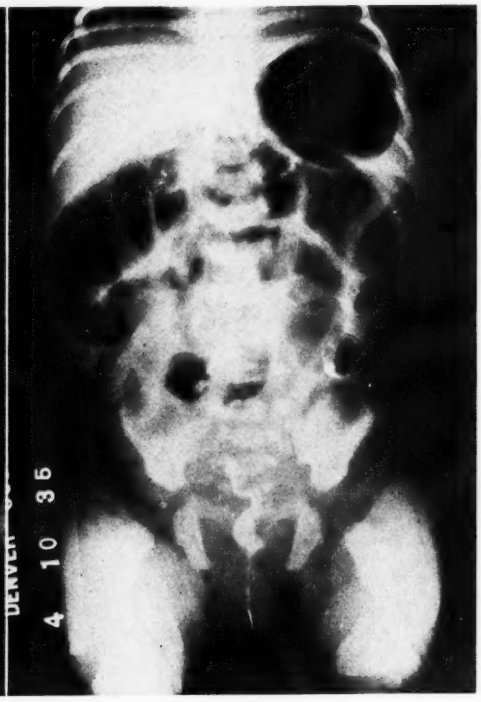

Fig. 2.

Fig. 1. Case 1. Enema could not be forced beyond the hepatic flexure region.
Fig. 2. Case 1. Almost complete evacuation of enema at the four-hour period; demonstrates motility.

Children's Hospital the first day after birth, April 9, 1935. He was given an x-ray examination the second day after birth. Cecostomy was performed the third day after birth. He died the fourth day after birth and an autopsy was performed. The roentgenologist's report was as follows:

"*Fluoroscopic Observations.*—Barium enema entered slowly, and only under considerable pressure with a bulb syringe. The rectum was narrow and would not balloon out. The enema followed the normal course of a colon and was forced as far as the right upper quadrant, where its passage was blocked. The caliber of the column of barium was only about 4 mm. throughout. *Films.*—These confirm the fluoroscopic findings and show the small column of barium following the same course as a colon. This film (Fig. 1), another four hours later (Fig. 2), and one on the following day (Fig. 3) show loops of gas-distended bowel, with progressive increase of distention, indicating small bowel obstruction. One of these loops followed, more or less, the course of the colon and radiographically might be either the colon or small bowel. *Opinion.*—Microcolon, probably with incomplete rotation, with cecum in the right upper quadrant, and obstruction near the ileo-cecal valve. Possible 'double-barrel' colon was not excluded."

EXCERPT FROM AUTOPSY RECORD

"The entire large bowel is greatly decreased in size, its diameter being 5 mm. from the cecum down as far as the rectum. The terminal portion of the rectum, however, shows a marked increase of the lumen compared with the size of the large bowel. The large intestine shows a complete lack of haustration. The descending and transverse colon are in the usual location, while the cecum is moved to the midline and is located just beneath the edge of the liver somewhat to the right of the mid-line. There is a sudden increase in the size of the gut in the region of the cecum, measuring 20 cm. in diameter, but beyond the cecum the terminal portion of the ileum shows again a decrease in size, measuring only 10 mm. in diameter. Following the gut orally (*sic*) from that point, it appears that there is a gradual increase in the lumen so that at the junction of the ileum and jejunum it reaches 30 mm. in diameter. The

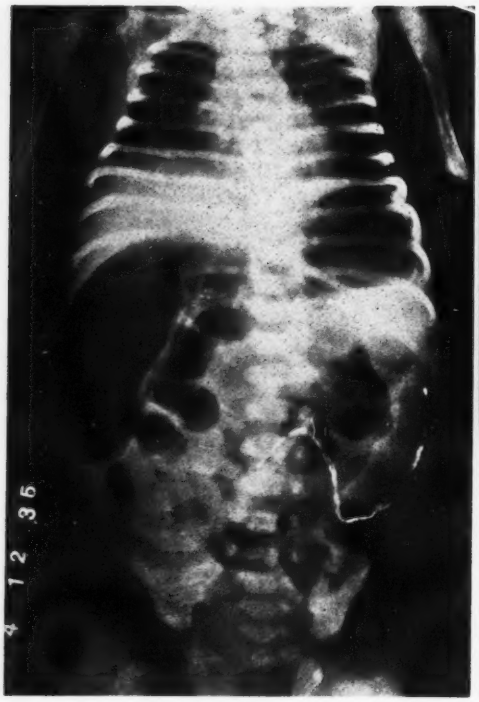

Fig. 3.

Fig. 4.

Fig. 3. Case 1. Roentgenogram taken at 36 hours. Note the smaller size of the column of barium; demonstrates contractility.

Fig. 4. Case 2. Enema forced past the splenic flexure with difficulty.

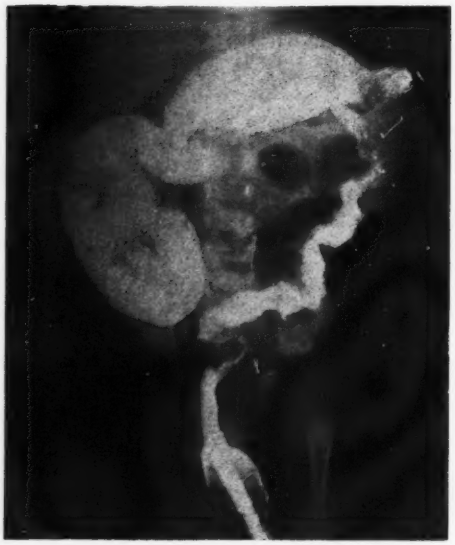

Fig. 5. Case 2. Continued pressure of enema caused it to enter the proximal dilated bowel, probably the ileum.

drain tube mentioned above is inserted in one of those distended guts. Stomach and duodenum appear essentially negative.... Upon the exploration of the heart it appears that the right ventricle is considerably enlarged and the musculature hypertrophied. Further examination discloses a large opening existing between the two auricles which is not merely a patency of the foramen ovale, but an incomplete development of the inter-auricular wall.

"*Diagnosis.*—Congenital microcolon; incomplete development of the inter-auricular septum."

Points of Especial Interest.—(1) The coexisting heart anomaly; (2) the hereditary factor. The baby was sent into the hospital because the attending physician, knowing that an infant brother of the patient had had an anomalous colon from which he died, feared that the failure of the patient to pass meconium indicated a similar anomaly. It was later learned that an infant son of the father's sister had died due to a colon anomaly. Thus, an infant boy, his brother, and a cousin all died soon after birth due to anomalous colons.

Case 2. Baby L., white, male, admitted to the Children's Hospital when two days old, died when seven days old, there having been no operation nor autopsy. The baby passed no meconium after birth, vomited up to the fourth day, then passed several stools. Rectal examination revealed a narrow, funnel-shaped rectum. An x-ray examination by enema was made on the fifth day.

Roentgenologist's Report.—"The bariumized enema passed just beyond the splenic flexure, where considerable resistance was encountered. The pelvic colon appeared very narrow. The sigmoid and descending portions of the colon were narrow and of irregular outline. *Films.*—Films at this point confirmed the fluoroscopic observations, but showed the barium to have passed on transversely across the abdomen (Fig. 4). Further injection was then done, and films showed a dilated bowel proximal to the splenic flexure, which could be partly colon and partly ileum, or all ileum. Definite gas-distended loops of small bowel were also present (Fig. 5). *Opinion.*—Congenitally small descending colon, especially narrow within the pelvis; probably bound down by congenital bands; possibly short colon, ending at splenic flexure—at least not extending proximal to the hepatic flexure. Signs of small intestinal obstruction."

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MULTIPLE MALIGNANCIES OF HEAD AND NECK

THREE INDEPENDENT LESIONS IN ONE PATIENT

By ASA B. FRIEDMAN, M.D.,[1] *and* MATTHEW G. GOLDEN, M.D.,[2] *New York City*

The subject of multiple primary carcinomas has been repeatedly studied and adequately reported. Shields Warren and Olive Gates[3] recently published an excellent review of cases, 1,259 in all, in the literature as well as of their own sources. Since then a few other reports have appeared, increasing somewhat the total number of reported cases. Many and bizarre combinations of primary malignancies are included in these large sources, but the particular coincidence of neoplasms that the case to be discussed presented was not included. The reader is referred to the paper of Warren and Gates for an excellent analytical review of the subject to date.

T. C., aged 64 years, was referred to the Cancer Division at Kings County Hospital, on June 8, 1934. His chief complaint was pain, of not more than seven weeks' duration, on the left side of his tongue which radiated toward his left ear and was aggravated by swallowing. For eight months previous to this he had been treated in the Medical Clinic for arteriosclerotic cardiorenal disease. His past history was irrelevant except for the fact that it showed that he had received treatment, in 1930, at another hospital for a laryngeal newgrowth, and that he had remained under the care of that institution until November, 1932. His family history was negative for carcinoma or other so-called "familial" diseases. A report from the other hospital stated that the patient had been treated in June, 1930, for an extrinsic carcinoma of the larynx reported pathologically as epidermoid carcinoma, transitionally Grade Two, moderately radiosensitive. He was given 28,000 mc.-hr. of radium externally to each side of his larynx and the equivalent of 760 mc.-hr. of radium treatment from gold seeds placed in the left pyriform sinus.

At the time of his first visit to our Clinic, physical examination showed the following: A rather obese, adult, white male, aged 64 years. His heart, lungs, abdomen, and extremities were essentially negative except for moderate signs of arteriosclerosis. Laryngeal examination by one of us showed an essentially normal larynx. Both cords moved normally. There was no evidence of recurrent or residual growth, and very little evidence of scarring. On the middle third of the left lateral border of his tongue there was an indurated, ulcerated, neoplastic lesion, well demarcated. The tonsillar pillars and tongue base were not involved.

Biopsy was reported by Dr. Hala, attending pathologist, as follows: "Section is one of tongue, including portion of the muscles. In some places the mucous lining is hypertrophied, with marked acanthosis and keratinization of the cells; elsewhere, there is ulceration, and the presence of numerous irregular islands of varied size consisting of large squamous epithelial cells showing here and there a tendency toward pearl formation. This growth infil-

[1] Visiting Radiation Therapist, Kings County Hospital, Division of Cancer, Department of Hospitals, New York City, Dr. Ira I. Kaplan, Director.
[2] Attending Otolaryngologist, Kings County Hospital.
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trates in some areas into the muscular zone. *Diagnosis:* Squamous-cell carcinoma of the tongue."

There were no palpable sub-maxillary or cervical glands.

Treatment.—Because of the fact that radiation had previously been given to the neck, only the primary lesion was treated, x-ray treatment of the neck now being omitted. Six radium element needles (2 mg., 3.2 cm., 0.5 mm. platinum) were inserted perpendicularly into the tongue, being equally spaced about the periphery of the palpable lesion. They were sown in place and allowed to remain 96 hours, giving a total dose of 1,152 mg.-hr. The expected radium reaction resulted, and the lesion healed with excellent epithelization of the area and a minimum amount of post-radium pain. The patient remained entirely well for over five months. On Nov. 1, 1934, on examination, a small indurated ulcer about 7 mm. in diameter was found on the lower edge of the right margin of the tongue. The entire lesion and the surrounding portion of the muscle was removed by an electrocoagulation loop. The base of the wound was then coagulated thoroughly. This specimen was reported by the pathologist as follows:

"The normal mucosa to a large extent is absent as a result of ulceration; it is replaced by a newgrowth of the epithelial type which infiltrates downward into the substance of the tongue, reaching the muscular strata in some areas. The growth is composed of squamous, polygonal, and large round epithelial cells rather closely packed, small nests of them being separated by a rather delicate reticular stroma; there is no attempt at full differentiation. Epithelial pearls are absent and the keratinization has not occurred; many of the cells show hyperchromatic nuclei and occasional mitotic figures are observed. From the histologic standpoint the tumor appears to be highly malignant. *Diagnosis:* Epidermoid carcinoma of tongue."

The periphery of the coagulated wound was then implanted with radium needles. The procedure was similar to that used in the first tongue lesion. A total dose of 600 mg.-hr. was given and the wound healed.

About six months later the patient was readmitted to the medical service because of an acute bronchial pneumonia. He died after admission. Autopsy was refused but the examination at the time did not show recurrence of the malignancy.

IRRADIATION OF MILK BY X-RAYS

By ROBERT C. WOODS, *Old Lyme, Conn.*

Following is a report of a short experiment on the treatment of milk by x-rays, carried out by the writer at the Gray Industrial Laboratories, Newark, N. J. All bacterial counts were done by I. R. Asen, Director of the Clinical Laboratory, Newark, N. J.

The x-ray machine used in this work was designed and operated primarily for industrial applications, and so, unfortunately, there was no method of calculating the actual dosages given in terms of r units or other measurements. This work is then of interest mostly because of the general effects obtained. The equipment used consisted of an ordinary 150 kv. generator with a half-wave, mechanical rectifier operating a universal, medium focus, Coolidge air-cooled x-ray tube. The tube was run at 38 kv., 5 ma., and the distance from target to surface of milk was 32 cm.; no filter was used.

To determine roughly the chances of obtaining some effect by irradiation of raw milk, a 150 c.c. sample of raw milk was exposed to the x-ray beam in a sterile cardboard container for ten minutes, a control sample of 150 c.c. being kept in a like container at as near the same temperature as possible. After a 48-hour incubation period, the number of bacteria groups in the treated milk was quite evidently larger than in the control, although no exact count was made at this time. Samples of treated and untreated milk, allowed to stand for seven days in covered sterile glass bottles, presented a marked difference in appearance. The irradiated milk showed a much more distinct cleavage of fluid from curd than the control, and gave a rancid, butyric acid odor instead of the normal sour-milk, lactic acid odor emitted by the control. Fluid from both samples was filtered and tested for *p*H, but no difference was found, although it was noted that fluid from the treated milk appeared much clearer after filtering than that from the untreated.

The experiment was repeated with more samples at different dosages and with more care. Using the same factors (38 kv., 5 ma., 32 cm. target-milk distance) three samples of raw milk, 150 c.c. each, were irradiated in sterile cardboard containers, a fourth sample being kept as a control. One sample was irradiated ten minutes, one fifteen minutes, and one for twenty minutes. Throughout the twenty-minute period, the room temperature was 80 F., the temperature of the room in which the control was kept remained the same, and the temperature in the x-ray beam rose from 80 F. to 92 F.

The four samples were then incubated for

48 hours in Standard Methods Formula (1.5 per cent nutrient agar, 3 grs. beef extract, 5 grs. peptone per liter), and plate counts were made from a dilution of from 1 to 10,000. The bacterial count (all types) was then as follows: untreated milk, 4,800,000; ten-minute sample, 11,000,000; fifteen-minute sample; 13,500,000; twenty-minute sample, 11,500,000.

All four samples, when kept in covered glass bottles over a three-day period, seemed to conform to the finding in the initial experiment. Fluid in the irradiated milk separated much sooner than in the untreated, and the rate and amount of separation appeared to correspond roughly to the treatment times. The irradiated milk, at the end of three days, showed many large air-pockets, and the curd was more solid and compact than in the unirradiated milk. As before, the control gave off the characteristic lactic acid odor, while the treated samples gave evidence of butyric acid. However, no test was made for the type of acid present.

The experiment was not carried further because of lack of time and facilities for exact dosage measurement. No theory was formed as to whether the effect found was due to a direct stimulation of bacterial growth or was caused by some photochemical change which made the surrounding medium more favorable for the support of such organisms.

If the effect found in this brief work could be developed further, it might well be used as a biological indicator of x-ray dosage.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

ROENTGENOLOGIC SYNDROMES

Disease, when typical in form, manifests itself in the patient by cardinal symptoms and signs. These cardinal symptoms and signs have been recorded by the medical profession for decades, and, in the case of many diseases, for centuries. They have, as a result, become so definitely a part of their respective diseases that, when they are found in certain groups or syndromes, no question is asked as to the diagnosis. One symptom or sign does not make a diagnosis, but a typical syndrome of a disease, running true to type, leaves no doubt in the physician's mind. A chill, a sudden rise of temperature, a cough, bloody sputum, pain in the chest, percussion dullness over a localized area of the lung, truly indicates pneumonia. A physician's skill is measured by his ability to not only elicit certain symptoms and signs of disease but also by his ability to analyze the symptoms and signs and put them together in their correct relations to each other as pointing to a certain disease. That ability marks the great physician.

It is interesting that one disease can be so completely differentiated from another disease as to make its diagnosis easy, as one plant from another, but it is even more interesting that the reaction of the various anatomical structures to each disease can be so different. After all, when the physician elicits certain symptoms and signs he is determining definite structural changes of anatomy and must so interpret them.

The roentgenologist portrays upon a film the anatomy of a patient and the pathological variations of this anatomy—structural changes indicative of disease. The skill of the roentgenologic physician is measured by his ability not only to evaluate these structural changes as pathological processes, but especially by his ability to put them together in definite groups as pointing to certain diseases—roentgenologic syndromes.

A roentgenologic syndrome can be as truly indicative of the structural changes of disease as any clinical syndrome. It does, however, require the knowledge of the clinical history to enable one to state that a given disease is the one which ails the patient. Gallstones and a diseased gall bladder might be demonstrated, a definite disease process, but the patient could be dying of leukemia.

The roentgenologic physician may become so engrossed in the demonstration of structural changes that he fails to grasp the larger significance of his findings. The demonstration of an irritable duodenum, a diseased appendix, and cecal stasis is important, but this roentgenologic syndrome may often mean an ulcer of the duodenum when a true ulcer deformity cannot be portrayed. Having succeeded in the accurate demonstration of anatomical changes and well along with the interpretation of these structural changes into terms of diseased processes, the roentgenologic physician can now begin to look forward to a greater grouping of roentgenologic syndromes as typical of certain diseases.

W. W. WASSON, M.D.

ANNUAL MEETING, NOV. 30—DEC. 4, 1936

TO THE RADIOLOGISTS OF NORTH AMERICA

In this issue of RADIOLOGY, you will find a Preliminary Program of the Annual Meeting of the Radiological Society of North America, to be held Nov. 30 to Dec. 4, 1936, in Cincinnati, with headquarters at the Netherland Plaza Hotel.

The Program Committee has endeavored to arrange interesting papers and discussions for each day of the meeting, with the thought of giving as varied a program as possible; always planning to cater to the wishes of the estab-

lished radiologists, but not forgetting or neglecting the desires of the younger men just entering the field of radiology. The Committee has attempted to give the radiologists of this country ample opportunity to present papers and clinics, feeling they are cognizant of the conditions under which our radiologists work, and their experiences and suggestions would be doubly valuable to the radiologists attending the meeting.

The Clinics have proved a popular feature of previous meetings, and, as you will note, Clinics are to be presented four afternoons during the meeting.

Dr. James T. Case, of Chicago, is to give the Carman Lecture and we are pleased to state that the members of the Cincinnati Academy of Medicine are to be guests of the Radiological Society on that occasion.

Many social activities have been planned by the local committee in Cincinnati and everyone will enjoy looking up old friends and acquaintances, and making new ones.

Looking forward to seeing you in Cincinnati, I am

Sincerely yours,

THOMAS A. BURCHAM, M.D., *President.*
Chairman, Program Committee.

CINCINNATI, THE HOST CITY

A few facts concerning the city in which the Annual Meeting of the Society is to be held may be interesting, as forming a background to a visit there.

Cincinnati has been an incorporated city since 1819. It is at present governed by nine councilmen, elected at large, who, in turn, elect a mayor to be the official head of the city for all ceremonial purposes. The council appoints the city manager, a trained administrator, who appoints and may remove all heads of departments and, subject to civil service provisions, is responsible for the appointment and removal of all other officers and employees in the administrative departments. The present city manager is Mr. Clarence A. Dykstra, student of political science and former member of the faculty of the University of California. Cincinnati's outstanding possession is her municipal government: she boasts of being "the best governed city in America."

The fact that the city has long been known as largely German in character is due to the immigration of a group of Germans about 1840. They wrote back to their kinsfolk in "the old country" that the Ohio Valley was "another Rhine Valley in appearance and fertility."

Tyler-Davidson Fountain on Fountain Square with the Hotel Netherland Plaza in the background.

The city is served by eight trunk line railroads, and is 300 miles from Chicago. At one period, its river traffic was its main communication with the country east and west. Now, much of the travel and traffic from the central South passes through Cincinnati. There has recently been completed a modern railway terminal. A municipal airport is located near the central part of town.

The Annual Meeting is to be held in the Netherland Plaza Hotel, modern, and luxurious in every way. There are other excellent hotels of the first class within easy distances,

among others, The Gibson, The Fountain Square, The Alms, and The Sinton. If you have not already made your reservation, you will assure yourself of more desirable accommodations by doing so at once.

PRELIMINARY PROGRAM

SCIENTIFIC PROGRAM
of the
TWENTY-SECOND ANNUAL MEETING
of the
RADIOLOGICAL SOCIETY
OF NORTH AMERICA

November 30–December 4, 1936

Netherland Plaza, Cincinnati, Ohio

Monday Morning, Nov. 30, 1936
Hall of Mirrors

9:00 A.M.

Call to order.....THOMAS A. BURCHAM, M.D.
President of the Radiological Society

SCIENTIFIC SESSION

10:00 A.M.

1. "Surgical Anatomy of the Abdomen." (Illustrated with lantern slides.) SAMUEL BROWN, M.D., University of Cincinnati, Cincinnati, O. (20 min.).

Discussion (5 min.) to be opened by SIDNEY LANGE, M.D., Cincinnati, O. (by invitation).

2. "Rare Developmental Abnormalities of the Adult Atlas." WALTER S. LAWRENCE, M.D., Memphis, Tenn. (10 min.)

Discussion (5 min.) to be opened by BYRON H. JACKSON, M.D, Scranton, Penna.

3. "Our Experience with Roentgen Examinations of University Freshmen during a Three-year Period." ERNST A. POHLE, M.D., PH.D., University of Wisconsin, Madison, Wisc. (20 min.).

Discussion (5 min.) to be opened by HENRY KENNON DUNHAM, M.D., Cincinnati, O.

4. "Late Results in Traumatically Displaced Epiphyses." OSCAR LIPSCHULTZ, M.D., Minneapolis General Hospital, Minneapolis, Minn. (20 min.).

Discussion (5 min.) to be opened by LEO G. RIGLER, M.D., Minneapolis, Minn.

5. "Roentgen-ray Evidence of Metastatic Malignancy in Bone." (Illustrated with lantern slides.) HENRY SNURE, M.D., Los Angeles, Calif., and GEORGE D. MANER, M.D., Los Angeles, Calif. (by invitation) (20 min.).

Discussion (5 min.) to be opened by W. EDWARD CHAMBERLAIN, M.D., Temple University, Philadelphia, Penna.

Monday Afternoon

2:00 P.M.

6. "Cancer of the Thyroid in Children." HUGH F. HARE, M.D., Lahey Clinic, Boston, Mass. (by invitation) (20 min.).

Discussion (5 min.) to be opened by U. V. PORTMANN, M.D., Cleveland Clinic, Cleveland, O.

7. "Radiotherapy in Catarrhal Deafness." FREDERICK J. O'BRIEN, M.D., Boston City Hospital, Boston, Mass. (20 min.).

8. "Congenital Absence of the Left Diaphragm." MAX KAHN, M.D., Baltimore, Md. (20 min.).

Discussion (5 min.) to be opened by HOWARD P. DOUB, M.D., Henry Ford Hospital, Detroit, Mich.

9. "Malignancy Involving the Duodenum." ALLAN TUGGLE, M.D., New York Hospital, New York City (20 min.).

10. "Roentgen Kymographic Studies in Clinical Cardiac Conditions." WENDELL G. SCOTT, M.D., Washington University School of Medicine, St. Louis, Mo. (by invitation) and SHERWOOD MOORE, M.D., Washington University School of Medicine, St. Louis (20 min.).

11. "The Use of Pento-barbital Sodium (Nembutal) for Roentgen Sickness: Report of 175 Cases." EUGENE T. LEDDY, M.D., Mayo Clinic, Rochester, Minn., and W. C. POPP, M.D., Mayo Clinic, Rochester, Minn. (by invitation) (20 min.).

Tuesday Morning, Dec. 1, 1936
Hall of Mirrors

9:00 A.M.

Symposium on Diseases of the Stomach and Gall Bladder

Arranged by LEO HENRY GARLAND, M.D., San Francisco, Calif.

12. "The Incidence and Classification of Hernias." MAURICE F. DWYER, M.D., Seattle, Wash. (20 min.).

Discussion (5 min.) to be opened by ERIC

J. RYAN, M.D., St. Luke's Hospital, New York City.

13. "The Rôle of the Vegetative Nervous System in the Clinical Roentgenology of the Upper Digestive Tract." ALFRED L. C. SIEFERT, M.D., Oakland, Calif. (20 min.).

Discussion (5 min.) to be opened by BYRL R. KIRKLIN, M.D., Mayo Clinic, Rochester, Minn.

14. "Non-carcinomatous Tumors of the Stomach." RAY ALDEN CARTER, M.D., Los Angeles, Calif. (20 min.).

15. "The Mobility of the Antrum, Pylorus, Duodenum, and Gall Bladder in Health and Disease: The Influence of Mobility in the Functioning of These Organs in the Biliary Tract." NATHAN B. NEWCOMER, M.D., Denver, Colo., and ELIZABETH H. NEWCOMER, M.D., Denver, Colo. (20 min.).

Discussion (5 min.) to be opened by ALFRED L. L. BELL, M.D., Long Island College Hospital, Brooklyn, N. Y.

16. "Effects of Peptic Ulcer on Emptying of the Gall Bladder." EDWARD A. BOYDEN, M.D., Minneapolis, Minn. (by invitation) (20 min.).

17. "Primary Tumors of the Small Intestine." EDWARD W. ROWE, M.D., Lincoln Clinic, Lincoln, Nebr. (20 min.).

"Biliary Dyssynergia: Disorders of Motility of the Extra-hepatic Biliary Tract" (to be read by title). HAROLD A. HILLS, M.D., San Francisco, Calif. (by invitation).

Tuesday Afternoon

2:00 P.M.

EXECUTIVE SESSION

Hall of Mirrors

Report of the Nominating Committee.

3:20 P.M.

18. "Excretory Urography." JOSEPH B. PRUESTLEY, M.D., Des Moines, Iowa (by invitation) (20 min.).

19. "The Roentgen Diagnosis of Lesions of the Upper Urinary Tract." CARL L. GILLIES, M.D., University of Iowa, Iowa City, Iowa, and H. DABNEY KERR, M.D., University of Iowa, Iowa City, Iowa (20 min.).

Discussion (5 min.) to be opened by BERNARD H. NICHOLS, Cleveland Clinic, Cleveland, O.

CARMAN NIGHT

Hall of Mirrors

8:00 P.M.

Wednesday Morning, Dec. 2, 1936

Hall of Mirrors

9:00 A.M.

20. "Carcinoma of the Bronchus." LOUIS H. CLERF, M.D., Philadelphia, Penna. (by invitation) (20 min.).

Discussion (5 min.) to be opened by LEO G. RIGLER, M.D., University Hospital, Minneapolis, Minn.

21. "Osteopetrosis." R. MANGES SMITH, M.D., Dept. of Roentgenology, Jefferson Hospital, Philadelphia, Penna., and AUSTIN T. SMITH, M.D., Dept. of Rhinology and Laryngology, Jefferson Hospital, Philadelphia, Penna. (by invitation) (20 min.).

Discussion (5 min.) to be opened by EDWARD L. JENKINSON, M.D., St. Luke's Hospital, Chicago, Ill.

22. "The Diagnosis of Parathyroid Dysfunction." EDGAR C. BAKER, M.D., Youngstown, O. (20 min.).

Discussion (5 min.) to be opened by EDGAR M. MCPEAK, M.D., Washington, D. C. (by invitation).

23. "Roentgen Methods of Studying the Soft Tissue Structures of the Neck." W. EDWARD CHAMBERLAIN, M.D., Temple University, Philadelphia, Penna., and ALBERT K. MERCHANT, M.D., Temple University, Philadelphia, Penna. (20 min.).

Discussion (5 min.) to be opened by SAMUEL M. BROWN, M.D., University of Cincinnati, Cincinnati, O., and SAMUEL IGLAUER, M.D., Professor of Otolaryngology, University of Cincinnati, Cincinnati, O. (by invitation).

24. "Pulmonary Pneumocele: Certain Considerations in Cystic Disease of the Lung." CARLTON B. PEIRCE, M.D., University of Michigan, Ann Arbor, Mich. (20 min.).

25. "Primary and Metastatic Pulmonary Malignancy Compared Clinically and Roentgenologically." JOHN T. FARRELL, JR., M.D., Jefferson Medical College, Philadelphia, Penna. (20 min.).

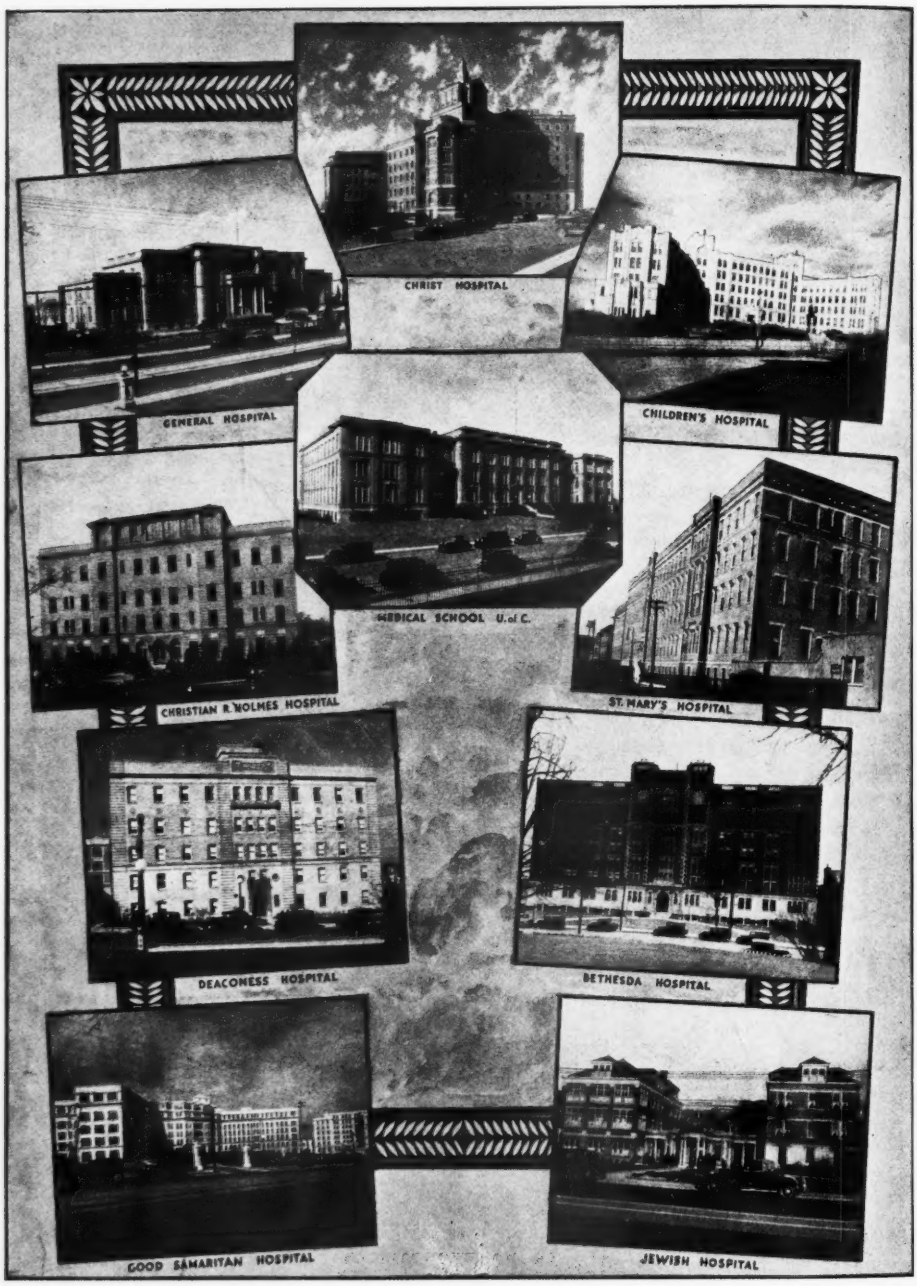
Discussion (5 min.) to be opened by JOHN D. CAMP, M.D., Mayo Clinic, Rochester, Minn.

Wednesday Afternoon

2:00 A.M.

Symposium on the Female Pelvis

Arranged by ROBERT A. ARENS, M.D., Chicago, Ill.



Cincinnati's leading hospitals and the College of Medicine.

26. "Value of Hysterosalpingography in Gynecological Diagnosis." ALBERT MATHIEU, M.D., Portland, Oregon (by invitation) (20 min.).

27. "A Comparison of Uterine Tubal Insufflation and Hysterosalpingography." LAWRENCE M. RANDALL, M.D., Dept. of Obstetrics and Gynecology, Mayo Clinic, Rochester, Minn. (by invitation) (20 min.).

28. "Why Pneumoperitoneum?" IRVING F. STEIN, M.D., Chicago, Ill. (by invitation) (20 min.).

29. "Roentgenography in Obstetrics." J. BAY JACOBS, M.D., Washington, D. C. (by invitation) (20 min.).

"Hereditary Multiple Ankylosing Arthropathy (Congenital Stiffness of the Finger Joints)" (to be read by title only). ARTHUR R. BLOOM, M.D., Detroit, Mich.

30. "The Circular Area of Tuberculous Infiltration." CARL C. BIRKELO, M.D., Detroit, Mich., and J. A. KASPER, M.D., Detroit, Mich. (by invitation) (20 min.).

Discussion (5 min.) to be opened by HENRY K. DUNHAM, M.D., Cincinnati, O.

Thursday Morning, Dec. 3, 1936
Hall of Mirrors

9:00 A.M.

Symposium on Therapy

Arranged by ARTHUR W. ERSKINE, M.D., Cedar Rapids, Iowa.

31. "Radiation Treatment of Malignancy of the Lip." IRA I. KAPLAN, M.D., Director Radiation Therapy Service, Bellevue Hospital, New York City (20 min.).

32. "A Study of Radium Technic in the Treatment of Carcinoma of the Rectum." HARRY H. BOWING, M.D., Section on Therapeutic Radiology, Mayo Clinic, Rochester, Minn., and ROBERT E. FRICKE, M.D., Section on Therapeutic Radiology, Mayo Clinic, Rochester, Minn. (20 min.).

33. "Peroral X-radiation in the Treatment of Intra-oral Cancers." HAYES E. MARTIN, M.D., New York City (by invitation) (20 min.).

34. "The Relation of Heredity and Environment to Cancer Occurrence." MAUDE SLYE, PH.D., Sprague Memorial Institute, University of Chicago, Chicago, Ill. (by invitation) (30 min.).

35. "Cancer of the Breast." URSUS V. PORTMANN, M.D., Cleveland Clinic, Cleveland, O. (20 min.).

36. "Practical Methods of Reducing the Cancer Death Rate." EDWARD H. SKINNER, M.D., Kansas City, Mo. (20 min.).

Discussion (10 min.) to be opened by ALBERT SOILAND, M.D., Los Angeles, Calif.

Thursday Afternoon

2:00 P.M.

EXECUTIVE SESSION

Hall of Mirrors

Election of Officers.

3:20 P.M.

37. "Treatment Record Designation of the Tumor Dose in Roentgens." EDWIN C. ERNST, M.D., Barnard Free Skin and Cancer Hospital, St. Louis, Mo. (20 min.).

38. "Should the Method of Coutard be Applied in All Cases of Cancer Treated by Roentgen Rays?" W. EDWARD CHAMBERLAIN, M.D., Temple University, Philadelphia, Penna., and BARTON R. YOUNG, M.D., Temple University, Philadelphia, Penna. (by invitation) (20 min.).

Symposium on Gastroscopy

Arranged by LEO G. RIGLER, M.D., Minneapolis, Minn.

39. "A Comparison of Gastroscopic and Roentgen Examinations." RUDOLPH SCHINDLER, M. D., University of Chicago, Chicago, Ill., and FREDERIC TEMPLETON, M.D., University of Chicago, Chicago, Ill. (by invitation) (20 min.).

40. "Gastroscopy." DR. RICHARD SCHATZKI, Massachusetts General Hospital, Boston, Mass. (by invitation) (20 min.).

41. "The Value of Gastroscopy." EDWARD B. BENEDICT, M.D., Massachusetts General Hospital, Boston, Mass. (by invitation) (20 min.).

Discussion: "A Critical Evaluation of Gastroscopy and Roentgenology in the Diagnosis of Diseases of the Stomach." BYRL R. KIRKLIN, M.D., Mayo Clinic, Rochester, Minn., and HERMAN MOERSCH, M.D., Mayo Clinic, Rochester, Minn. (by invitation).

The skyline of Cincinnati.

Friday Morning, Dec. 4, 1936

9:00 A.M.

Symposium on the Chest

Arranged by W. WALTER WASSON, M.D., Denver, Colo.

42. (Five papers will make up this Symposium, titles and authors to be shown in the final program.)

Discussion (5 min.) to be opened by HENRY K. DUNHAM, M.D., Cincinnati, O.

47. "New Method for Examination of Sacro-iliac Joints." GAGE CLEMENT, M.D., St. Luke's Hospital, Duluth, Minn. (20 min.).

Discussion (5 min.) to be opened by JOHN BARNES, M.D., Buffalo, N. Y.

48. "Traumatic Injuries of the Kidneys." ROY P. POTTER, M.D., Marshfield Clinic, Marshfield, Wisc., and W. G. SEXTON, M.D., Urologist, Marshfield Clinic, Marshfield, Wisc. (by invitation) (20 min.).

Friday Afternoon

2:00 P.M.

Symposium on Physics

Arranged by OTTO GLASSER, PH.D., Cleveland Clinic, Cleveland, Ohio.

49. "The Biological Action of Neutron Rays." JOHN H. LAWRENCE, M.D., Department of Internal Medicine, Yale University School of Medicine, New Haven, Conn. (by invitation); PAUL C. AEBERSOLD, M.D., Division of Roentgenology, University of California Medical School, Berkeley, Calif. (by invitation); ERNEST O. LAWRENCE, M.D., Radiation Laboratory, Department of Physics, University of California, Berkeley, Calif. (by invitation) (20 min.).

Discussion (5 min.) to be opened by KENNETH E. CORRIGAN, PH.D., Harper Hospital, Detroit, Michigan (by invitation).

50. "Clinical Deductions from Physical Measurements on 200 kv. and 1000 kv. X-ray Apparatus." ROBERT S. STONE, M.D., University of California Hospital, San Francisco, Calif., and PAUL C. AEBERSOLD, M.D., Division of Roentgenology, University of California Medical School, Berkeley, Calif. (by invitation) (20 min.).

Discussion (5 min.) to be opened by OTTO GLASSER, PH.D., Cleveland Clinic Foundation, Cleveland, Ohio.

51. "An Oil-immersed X-ray Generating Outfit for 500,000 Volts and an Oil-immersed Multi-sectional X-ray Tube." E. E. CHARLTON, PH.D., Research Laboratory, General Electric Company, Schenectady, New York (by invitation); GEORGE HOTALING, Research Laboratory, General Electric Company, Schenectady, New York (by invitation); W. E. WESTENDORP, Research Laboratory, General Electric Company, Schenectady, New York (by invitation); L. E. DEMPSTER, Research Laboratory, General Electric Company, Schenectady, New York (by invitation) (20 min.).

Discussion (5 min.) to be opened by ERNEST O. LAWRENCE, Radiation Laboratory, Department of Physics, University of California, Berkeley, Calif. (by invitation).

52. "X-ray Measurements with Liquid Ionization Chambers." LAURISTON S. TAYLOR, PH.D., Bureau of Standards, Washington, D. C. (20 min.).

Discussion (5 min.) to be opened by G. C. LAURENCE, Canadian National Research Council, Ottawa, Canada.

53. "Further Studies on the Rate of Recovery of Human Skin from the Effects of

Roentgen- or Gamma-ray Irradiation." EDITH H. QUIMBY, M.A., Memorial Hospital, New York City, and WILLIAM S. MACCOMB, M.D., Memorial Hospital, New York City (20 min.).

Discussion (5 min.) to be opened by JAMES L. WEATHERWAX, M.A., Philadelphia General Hospital, Philadelphia, Penna.

54. "Dosage Measurements with the Thimble Chamber" (by title). OTTO GLASSER, PH.D., Cleveland Clinic Foundation, Cleveland, Ohio (20 min.).

Discussion (5 min.) to be opened by LAURISTON S. TAYLOR, PH.D., Bureau of Standards, Washington, D. C.

CLINICS

Clinics will be held every afternoon, with the exception of Thursday, from four to five o'clock.

AUTHOR	TITLE
BYRL R. KIRKLIN, M.D., Rochester, Minn.	Cholecystography
URSUS V. PORTMANN, M.D., Cleveland, O.	X-ray Treatment of Malignant Thyroid
ROBERT B. TAFT, M.D., Charleston, S. C.	(Later)
WALTER W. WASSON, M.D., Denver, Colo.	Differential Diagnosis of Pulmonary Diseases
MAX KAHN, M.D., Baltimore, Md.	Bone Tumor
(Round table discussion on interesting films. cases, with abstract of history.)	Members, please bring films of your puzzling
LEO H. GARLAND, M.D., San Francisco	Silicosis
ARTHUR W. ERSKINE, M.D., Cedar Rapids, Iowa	What does the Lesion Get?
W. EDWARD CHAMBERLAIN, M.D., Philadelphia	Radiologist's Part in the Problem of Low Back Pain
WILLIAM E. COSTOLOW, M.D., Los Angeles	Three Years' Experience with 500 kv.
GEORGE LYFORD, M.D., Cincinnati, O.	Salpingography
PHILIP J. HODES, M.D., Philadelphia	Pneumoconiosis
ZOE A. JOHNSTON, M.D., Pittsburgh	Practical Treatment of Carcinoma of the Uterus by X-ray and Radium

ANNOUNCEMENT

FLORIDA STATE RADIOLOGICAL SOCIETY

The Florida State Radiological Society announces its officers for the ensuing year: *President*, F. J. Payton, M.D., of Miami Beach; *Vice-president*, G. Raap, M.D., of Miami; *Secretary*, Harold O. Brown, M.D., of Tampa.

Meetings are held twice a year, in May and November.

COMMUNICATIONS

AN IMPORTANT DECISION

The following interesting communication has been received by the Editor from L. Henry Garland, M.D., of San Francisco, Secretary of the Executive Committee of the Pacific Roentgen Club:

"In view of current comment concerning the recent Supreme Court opinion in this State on the subject of nurse anesthetists, I think that the following facts should be brought to the attention of your readers.

"The opinion in question has been publicized in the newspapers under the heading 'Lay Persons may Legally Give Anesthetics.' The possibility of an analogous erroneous deduction regarding radiology is immediately apparent. Now, the actual opinion states that a *Registered Nurse* may, under the *immediate direction* and *supervision* of the operating surgeon and his assistant, give an anesthetic. The only application of this decision to radiology is that it might be construed to permit x-ray technicians to perform certain functions under the immediate and direct supervision of a radiologist. However, there are definite regulations in this State dealing with the training and registration of nurses, but there are none dealing with x-ray technicians; hence, no direct analogy necessarily arises.

"The decision in question was rendered following a series of rather unfortunate circumstances.

First of all, the original suit was started by a small group of physician-anesthetists in Los Angeles, to enjoin and restrain a Registered Nurse from giving anesthetics in Saint Vincent's Hospital. The suit was not started by the official medical association of the State and it was not until after an unfavorable decision had been rendered in the lower court that the California Medical Association was asked to intervene. This it did unsuccessfully and at considerable expense. The main reason given by the Court for deciding in favor of the defendant lay anesthetist and the hospital was the nature of the testimony given by certain well-known surgeons on the staff. These surgeons testified that lay (nurse) anesthesia was an established and accepted practice in that hospital; they testified under oath that they *personally* directed the administration of the anesthetic during the operation!!! The Court was more impressed by this testimony than by any other. The surgeons now heartily regret having given the testimony that they did, but, apparently called to the defense of their institution by what seemed like a local case, they did their best to defend it and gave the testimony referred to. Since then, the case has assumed statewide and national proportions. These physicians now realize that it would have been better to have openly admitted that, in general, anesthetics should be given by duly licensed physicians, since the operating surgeon is usually far too busy to 'direct and supervise the anesthetist' . . . even if he were able to do so; and that the administration of so dangerous a drug as an anesthetic is indeed the practice of medicine. For the information of those readers who are interested the actual opinion may be secured.[1]

"Now comes the question of trying to rectify matters. It is the opinion of some authorities that, if a suit were commenced on the merits of the case alone and not on the subject of enjoining any particular charitable institution from following certain practices, it would probably be successfully prosecuted. Unfortunately, such a suit would be an expensive undertaking and the California Medical Association is in no position to finance it at the present time. Perhaps the Sections on Anesthesiology of some of the larger state and national associations might pool some of their reserves and prosecute the matter as a joint constructive venture."

[1] By addressing Pacific Roentgen Club, 450 Sutter St., San Francisco.

THE AMERICAN BOARD OF INTERNAL MEDICINE (INC.)

The American Board of Internal Medicine, incorporated Feb. 28, 1936, completed its organization on June 15, 1936. The officers chosen were Walter L. Bierring, M.D., Des Moines, Chairman; Jonathan C. Meakins, M.D., Montreal, Vice-chairman, and O. H. Perry Pepper, M.D., Philadelphia, Secretary-Treasurer. These officers with the following six members constitute the present membership of the board: David P. Barr, M.D., St. Louis; Reginald Fitz, M.D., Boston; Ernest E. Irons, M.D., Chicago; William S. Middleton, M.D., Madison; John H. Musser, M.D., New Orleans, and G. Gill Richards, M.D., Salt Lake City.

The organization of the Board is the result of effective effort on the part of the American College of Physicians in conjunction with the Section on Practice of Medicine of the American Medical Association and these two organizations are represented in the membership of the Board on a five to four ratio, respectively.

The American Board of Internal Medicine had previously received the official approval of the two bodies fostering its organization, as well as that of the Advisory Board for Medical Specialties and the Council on Medical Education and Hospitals of the American Medical Association.

The purpose of the Board will be the certification of specialists in the field of internal medicine, and the establishment of qualifications with the required examination procedure for such certification.

While the Board is at present chiefly concerned with the qualification and procedure for certification in the general field of internal medicine, it is intended to inaugurate immediately after July 1, 1937, similar qualification and procedure for additional certification in certain of the more restricted and specialized branches of internal medicine, as gastroenterology, cardiology, metabolic diseases, tuberculosis, allergic diseases, *et cetera*. Such special certification will be considered only for candidates who have passed at least the written examination required for certification in general internal medicine. The operation of such a plan will require the active participation and co-operation of recognized representatives from each of such special fields of medicine.

Method of Examination

The examination required of candidates for certification as specialists in Internal Medicine will comprise, Part I (written) and Part II (practical or clinical).

Part I. The written examination is to be held simultaneously in different sections of the United States and Canada and will include:

(*a*) Questions in applied physiology, physiological chemistry, pathology, pharmacology, and the cultural aspects of medicine.

(*b*) Questions in general internal medicine.

The first written examination will be held in December, 1936, and candidates successful in this written test will be eligible for the first practical or clinical examination which will be conducted by members of the Board near the time for the annual session of the American College of Physicians at St. Louis in April, 1937. The second practical examination will be held at Philadelphia near the time of the annual session of the American Medical Association in Atlantic City in June, 1937.

The fee for examination is forty dollars, which must accompany the application, and an additional fee of ten dollars is required when the certificate is issued.

Application blanks and further information may be obtained by addressing the office of the chairman, Walter L. Bierring, M.D., 406 Sixth Avenue, Des Moines, Iowa, U. S. A.

IN MEMORIAM

ED. C. JERMAN, D.Sc.

Many members of the Radiological Society of North America will learn with sadness of the passing, on Sept. 13, 1936, of Mr. Jerman, so long and intimately identified with the x-ray industry. He was born in 1865, in Ripley County, Indiana, and during the course of his life travelled widely and made many friends. From 1918 until his retirement in 1934, he was engaged in educational work along the lines of technical procedure. Many of his written articles have been published by various medical, hospital, and x-ray journals, including a series of articles for RADIOLOGY and nearly a hundred "Service Suggestions." His first x-ray book was published during the early twenties, and an entire edition was soon sold. His second and best known x-ray book, "Modern X-ray Technic" (First edition, 1928), has been sold throughout the world, several printings being made in order to supply the demand. It still is in demand, being used as a text-book by many teaching institutions. Two printings, translated into Spanish, have supplied the Latin-American countries. Intermittently during a period of five years, he conducted an original research study of the Egyptian and Peruvian mummies at the Field Museum of Natural History, Chicago. More than two thousand radiographs of various parts of nearly one hundred and fifty mummies were made in a pathologic study of these subjects. A monograph has been prepared and published by the museum as a result of the professional study of these radiographs.

The late Ed. C. Jerman, D.Sc.

Mr. Jerman was a charter member of the American Roentgen Ray Society; an associate member of the American Institute of Electrical Engineers for many years; an honorary member of the British Society of Radiographers; co-founder, President, and President Emeritus of the American Society of X-ray Technicians. For a period of eight years, he was examiner for the American Registry Board. He conducted the examinations of the first one thousand American and Canadian technicians to be registered by the American Registry Board. Since 1920 he travelled through more than thirty foreign countries, introducing his work of technical instruction.

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S. M. ATKINS, M.D., of Waterbury, Connecticut
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CONTENTS OF ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

ACTINOMYCOSIS

Roentgen Therapy of Actinomycosis. S. Keijser. Strahlentherapie, 1936, **56,** 449–455.

During the period of 1920–1935 a total of 101 patients with actinomycosis were treated in the author's clinic. Sixty-nine patients had cervical involvement, 27 abdominal involvement, and in five the lesions were located in the thorax and other parts of the body. Technic of roentgen therapy: 170–180 kv., 0.5 mm. Cu, 30–60 cm. F.S.D., 75–85 per cent of the skin erythema dose per field. In about 50 per cent of the patients, one series was sufficient; in the others it was repeated after from six to eight weeks. Radiation therapy was combined with the oral administration of 6 grams of KJ daily. Injections of "Fuadin" (antimone preparation) were also tried and proved to be effective occasionally. Of the 69 patients with lesions in the cervical areas, 67 were cured or are close to it at this time and only two died. Of the 27 patients with abdominal involvement, nine were cured. Of the last group of five cases, only one was cured; the other patients died. Further study of the use of the antimone in the treatment of actinomycosis is recommended.

ERNST A. POHLE, M.D., Ph.D.

APPARATUS

A Brace for the Transportation and Handling of Patients with Injuries of the Cervical Vertebræ. Louis T. Wright. Jour. Am. Med. Assn., April 25, 1936, **106,** 1467, 1468.

This brace was designed primarily to allow roentgenographic examination without interference in the lateral and anteroposterior exposures. It is so solidly and firmly constructed that it will not slip when once applied. It is adjustable, and any degree of hyperextension and traction on the head is easily obtained by means of four turnbuckles. The chin piece is so arranged that it can be turned down out of the way when one finds it necessary to take a roentgenogram through the open mouth. It is capable of being applied at the scene of an accident and valuable in the transportation of a patient.

CHARLES G. SUTHERLAND, M.B. (Tor.).

Roentgen Therapy with Super-high Voltage Apparatus. Albert Soiland. Strahlentherapie, 1936, **56,** 521–525.

The author briefly describes an 800 kv. generator, operating a tube at 400 kv., with a filter of 8 mm. of lead. At a tube current of 4 ma., the output is 15 r per minute. As several advantages of super-high voltage therapy, particularly from a practical standpoint, the author lists the following: the systemic reaction is less than with the conventional 200 kv. therapy when comparing equal depth doses; the skin erythema is milder; there is less influence of the time factor; several patients can be treated at the same time; the therapeutic effects manifest themselves more quickly, and deep-seated malignancies are much more thoroughly destroyed than with the usual 185 kv. technic.

ERNST A. POHLE, M.D., Ph.D.

Roentgenographic Control of the Central Ray in Deep Therapy. G. Herrnheiser. Strahlentherapie, 1936, **56,** 437–448.

The author analyzes the various sources of error which may occur when adjusting the ports of entry in x-ray deep therapy. He outlines the advantages which are gained by fluoroscopic control of the treatment fields and describes the principles of its application.

ERNST A. POHLE, M.D., Ph.D.

Radiation Therapy through a Lattice with Square Holes: The Importance of the "Untreated Interspace." B. Grynkraut and W. Sitkowski. Strahlentherapie, 1936, **56,** 413–421.

The authors constructed several lattices with square holes using 2 mm. of lead. Tests were then undertaken with the ionization chamber in air. The loss of intensity with 100 kv. was 20 per cent and with 180 kv., 6 per cent. Other tests on photographic film, on rabbits, and on human skin were also carried out. The erythema on the human skin was milder if the lattice was used, provided equal doses were applied to skin areas with and without the lattice. It is concluded, therefore, that the tolerance of the skin is increased by means of the lattice and higher doses can be applied without permanent skin damage. What effect the use of this method has on the radiation absorbed in the inner organs is being studied.

ERNST A. POHLE, M.D., Ph.D.

ARTHRITIS

Pain in the Shoulder Girdle, Arm, and Precordium Due to Cervical Arthritis. Samuel S. Hanflig. Jour. Am. Med. Assn., Feb. 15, 1936, **106,** 523–526.

The syndrome of cervical arthritis, more often the hypertrophic variety, associated with pain referred to the shoulder and arm, and more rarely to the precordium in a pseudo-angina fashion, is common. The author regards the pain as a manifestation of initiation or actual inflammation (radiculitis) of cervical spinal nerve roots by arthritis.

The experimental work of Nathan suggested such an explanation. The nerve roots may be involved by adhesions or pressure of soft tissue swelling or by pressure of osteophytes with their associated soft tissue inflammation and synovial thickening. Symptoms may vary from paresthesias and numbness to severe pain along any of the sensory or segmental nerves, depending on the degree of mechanical interference with the roots as they emerge from the cord.

Treatment by stretching and manipulation, using a Sayre sling suspension apparatus, followed by graded exercises in rotation, flexion, and extension showed be-

ginning relief of pain in two or three days and has been used as a diagnostic test in a limited series of cases.

CHARLES G. SUTHERLAND, M.B. (Tor.).

BIOLOGIC EFFECTS OF RADIATION

Experiments on *Drosophila melanogaster* Regarding the Influence of the High Frequency Field and Ether Anesthesia on Mutations Produced by Roentgen Rays and Gamma Rays of Radium. A. Pickhan, N. W. Timoféeff-Ressovsky, and K. G. Zimmer. Strahlentherapie, 1936, **56,** 488–496.

In a series of experiments on the fruit fly the authors determined the rate of mutations following exposure to certain doses of x-rays and radium. An exposure of the test object to a 6-meter wave or ether anesthesia did not have any effect on the rate of mutations.

ERNST A. POHLE, M.D., Ph.D.

BONE DISEASES (DIAGNOSIS)

The Parathyroid Glands and Diseases of the Bones. Editorial. Jour. Am. Med. Assn., May 2, 1936, **106,** 1566.

Recent contributions to the literature covering this interesting subject are reviewed in such a manner as to correlate their subject matter with the existing knowledge and theories. The skeleton, in addition to being an inert supporting structure, serves as a reservoir for calcium and phosphorus in which or from which these elements may be deposited or withdrawn according to the needs of the body. The deposition of the quantity absorbed from the gastro-intestinal tract and the withdrawal of these elements is under the influence of the hormone secretion by the parathyroid gland. Recent experiments seem to show that this substance plays a decisive part in the regulation of the calcium ion concentration of the blood. Hypertrophy of the gland apparently results in an increase in the amount of parathyroid hormone secreted in the blood stream and thus produces demineralization of the bones. Primary hyperparathyroidism is caused by a tumor of one or more of the parathyroid glands. Secondary hyperparathyroidism signifies alterations in the structure and activity of the parathyroid glands encountered in certain bone diseases such as rickets, "renal rickets," and osteomalacia, presumably representing a compensating response. This has been observed in some cases of carcinoma with metastases to the bone, chronic nephritis, nephrolithiasis, and multiple myeloma.

CHARLES G. SUTHERLAND, M.B. (Tor.).

BREAST CANCER

The Treatment of Carcinoma of the Breast by Simple Removal of the Tumor Followed by Roentgen Therapy. J. Borak. Strahlentherapie, 1936, **56,** 200–204.

During the last ten years the author has irradiated 26 women following simple removal of a carcinoma of the breast. Nine out of the first 11 patients developed metastases. The total doses amounted to from 1,000 to 2,500 r. The next 12 cases received doses as high as from 3,000 to 6,000 r and only one recurrence developed. These figures are based on a period of observation of one and one-half years. During the same interval 80 per cent of the first group had bone metastases. Technic: two fields are usually given, one over the anterior breast and one over the axilla. The supraclavicular region is not irradiated. Eight to fourteen days after the operation 12 sittings of 300 r each (170 kv., 0.5 mm. Zn, 40 cm. F.S.D.) are given over one area and if the systemic reaction is not too severe, followed immediately by exposures over the second field. Several photographs of a patient treated with this method in 1927 and still well to-day are appended.

ERNST A. POHLE, M.D., Ph.D.

CANCER (THERAPY)

Roentgen Therapy of Carcinoma of the Hypopharynx. Jens Juul and Ove Strandberg. Strahlentherapie, 1936, **56,** 259–272.

The authors relate their experience in the treatment of 49 cases of carcinoma of the hypopharynx. A Coutard technic was employed: 165–180 kv., 2–4 ma., Thoraeus filter, half value layer in copper = 1.5 mm., 50–70 cm. F.S.D., 2.5–5.0 r per minute, 48–150 sq. cm. field size, two sittings per day. It is quite essential that the general condition of the patient should remain good; the presence of heart disease is an undesirable complication. Careful hygiene of the mouth should be stressed. In the authors' experience the production of a confluent epithelitis in the mucous membrane is not absolutely necessary although this is emphasized by Coutard. Of the 49 patients seen in the last four years, 14 remained free from symptoms after the treatment, four were hopeless when entering, 13 could not be completely treated, 18 were only temporarily relieved.

ERNST A. POHLE, M.D., Ph.D.

The Value of Klein's Reaction in the Treatment of Carcinoma. W. Dieterich. Strahlentherapie, 1936, **56,** 396–406.

The author studied the test described by Klein for the recognition of cancer and the early diagnosis of a recurrence. A total of 409 patients with primary carcinoma and 76 patients with a recurrence were used for the investigation. The principles of the method are described as follows: Cell suspensions of certain animal cancers or sarcomas of equal age are treated in the same manner and added to the serum of the patient to be examined. The cells are counted at the beginning of the test and after a certain time. A comparison of the two figures obtained permits certain conclusions which lead to a positive or negative diagnosis. In order to rule out mistakes due to the personal error of counting, the microscopic fields are photographed and thus a permanent record is established. In the author's investi-

gation the accuracy of the method amounted to 95.2 and 92 per cent, respectively, in the two groups mentioned above.

ERNST A. POHLE, M.D., Ph.D.

General Body Exposure with Roentgen Rays at Long Distance in Generalized Carcinomatosis. Lucien Mallet. Strahlentherapie, 1936, **56,** 278–284.

The author used general body exposure with roentgen rays in the treatment of patients with advanced and metastasizing carcinoma. Technic: 200 kv., 1.3 mm. Cu, 120 cm. F.S.D., 40 × 40 cm. field size, 25–100 r per area and sitting, two hours per sitting. At times, two patients were treated simultaneously by increasing the F.S.D. to 2 meters. Most patients received treatment over a period of from two to eight months, with an interval between series of from several weeks to two months. This general plan, however, was modified to suit the requirements of the individual case. The blood picture was checked every 14 days—if the erythrocytes went down to 3,000,000 and the white blood cells to 2,500, it was found that irradiation should be discontinued. Since 1933, a total of 150 patients have been treated with this method. While it is too early to offer definite conclusions, the preliminary results have been encouraging even in hopeless cases.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Therapy of Carcinoma of the Cervix with Super-high Voltage Apparatus. Gunsett. Strahlentherapie, 1936, **56,** 422–436.

The author briefly describes the super-high voltage unit which has been installed at the Cancer Center in Strassburg. The results of his series of physical measurements are given. A comparison is then made of the skin doses given with the 200 and 520 kv. technic in carcinoma of the cervix. If two anterior and two posterior areas were used, it required approximately 3,400 r per field, or 30 hr. and 46 min. to administer a dose in the tumor of 3,600 r with 200 kv. and 50 cm. F.S.D. The respective figures for 520 kv. at 1 meter F.S.D. are about 2,200 r per field and 20 hr. and 18 min. total treatment time. The considerable drop of the skin surface dose and the decrease in the treatment time as compared with the 200 kv. technic are obvious. The ratio between skin and depth dose with the 200 kv. technic can, however, be improved by increasing the F.S.D. to 100 centimeters. The drop in intensity due to increase in distance can be at least partially compensated by an increase in tube current. Future studies will show which of the two methods, super-high voltage or 200 kv. radiation with high tube currents, is preferable.

ERNST A. POHLE, M.D., Ph.D.

THE COCCYX

Roentgen Therapy of Coccygodynia. C. I. Baastrup. Strahlentherapie, 1936, **56,** 184–188.

The term "coccygodynia" was proposed in 1859 by Simpson and defined as pain in the region of the coccyx. The symptoms consist mainly of pain when sitting down, difficulty in sitting still and in raising from the chair, the os coccyx being tender to pressure. Of 15 cases of this type treated by the author, eight were of non-traumatic and seven of traumatic origin. Ten patients were cured by x-ray therapy; in two cases only was there a complete failure of treatment. Technic: 300 r, 5 mm. Al or 0.5 mm. Cu. The method should be given a trial in men and also in women beyond the menopause.

ERNST A. POHLE, M.D., Ph.D.

CONTRAST MEDIA

Extraneous Shadows Complicating Urography, with Special Reference to Radiopaque Pills. Adolph Hartung and T. J. Wachowski. Jour. Am. Med. Assn., Feb. 22, 1936, **106,** 596–598.

These authors report three cases in which radiopaque pills were visualized and offered difficulty in diagnosis. Reviewing the literature, they compiled a list of entities that may simulate renal concretions. These included material in the bowel, such as fecal masses, enteroliths (in the bowel or appendix), fruit pits, opaque salts (especially residues of bismuth or barium in diverticula of the colon), pills of ferrous carbonate, and capsules, containing phenyl salicylate. Gallstones, calcified glands, calcified tuberculous foci in the kidney, calcified tumors in the pancreas or in contiguous structures, calcified areas in the spleen, calcification in a blood clot or surrounding a foreign body (including phleboliths) may simulate renal or ureteral calculi. Fibromas, warts, and scars have been mistaken for them. Artefacts present in the film or screen and superimposed shadows of clothing may be confusing.

Ammonium chloride and sodium acid phosphate, the former in enteric-coated pills, cast shadows, in their experience. They combined 35 pills and tablets in one roentgenogram to demonstrate the comparative densities.

CHARLES G. SUTHERLAND, M.B. (Tor.)

Ventriculography with Colloidal Thorium Dioxide. Walter Freeman, Herbert H. Schoenfeld, and Claude Moore. Jour. Am. Med. Assn., Jan. 11, 1936, **106,** 96–100.

The authors and their colleagues have used colloidal thorium dioxide for ventriculography in about twenty cases over a period of two years. Advantages are that it is freely miscible with the ventricular fluid, permitting ready diffusion throughout the cavities. It is also of high specific gravity, tending to reach the dependent points in the ventricular system, outlining the aqueduct and the fourth ventricle.

It is of high radiopacity, so that only small quantities are necessary for the satisfactory visualization of the whole system. In cases in which the fluid pathways are free from obstruction it passes readily to the subarachnoid space and is eliminated within four hours from the cranial cavity, at least in amounts detectable by the roentgen ray. Most important of all, the pres-

sure relationships within the cranial cavity are not disturbed, since the liquid cushion on which the brain is borne does not have to be removed in order to obtain a clear film. There is no immediate discomfort and usually no sensation at all.

The greatest danger in the use of the method seems to lie in the inflammatory effects in cases in which the ventricular system is obstructed. In their work the authors have not met with any disastrous results following the retention of thorium in the ventricular system. From published reports, the introduction of the material into the basal cistern is accompanied by some danger, a few deaths having been reported.

Ventriculograms afford a complete outline of the ventricles in favorable cases. In no case have the authors used more than 6 c.c. of the thorium dioxide. When the ventricle is found with difficulty and only a few drops of fluid are obtained it is still possible to secure satisfactory roentgenograms. The taking of satisfactory films is facilitated by the perfect co-operation usually possible on the part of the patient.

In 20 cases there were two deaths and two severe reactions. The authors' first patient is in his usual health twenty months after the injection.

CHARLES G. SUTHERLAND, M.B. (Tor.)

DEFICIENCY DISEASES

Multiple Specific Nutritional Deficiency Disease in the Adult. Russell L. Haden. Jour. Am. Med. Assn., Jan. 25, 1936, **106,** 261–265.

Specific nutritional deficiency disease represents abnormalities arising from a lack of the specific elements in nutrition which are normally supplied by the food or are formed directly from food in the gastro-intestinal tract. In the present state of our knowledge the more important specific substances the lack of which leads to nutritional defects in the adult are: (1) calcium; (2) iron; (3) vitamins A, B, B_2 (G) and C, and (4) the anti-pernicious anemia factor.

Pellagra, beriberi, and scurvy usually represent extreme deficiencies and are seldom seen in this country. Minor deficiency states are common. A deficiency in each specific nutritional element results in characteristic signs and symptoms; certain diseases such as neuritis of pregnancy or alcoholism, formerly thought due to some positive toxic agent, are now proved due to the lack of specific nutritional elements. Deficiency may be due to a deficient intake of the specific food factors for normal needs, an insufficient supply for abnormal needs as in pregnancy, a defect in absorption, or a disturbance in utilization. Almost every tissue of the body may be affected by a deficiency in a food factor.

While not specifically mentioning any roentgenologic features, this review is interesting in view of the knowledge we now have of the dependence of the endocrine glands for proper functioning on an adequate diet and the evident interlacing of these factors in changes in the roentgenographic image of bone.

CHARLES G. SUTHERLAND, M.B. (Tor.)

DIATHERMY

The Super-high Pressure Lamp. G. J. van der Plaats. Strahlentherapie, 1936, **56,** 497–506.

The author describes a new type of quartz mercury vapor lamp which works under a pressure of about one hundred atmospheres at a temperature of 8,600°. Spectral analysis showed that, with increasing pressure, the specific mercury lines decrease in intensity and the lamp becomes principally a source of red and infra-red light. The possibilities of its use in medical practice are discussed.

ERNST A. POHLE, M.D., Ph.D.

THE ESOPHAGUS

Roentgen Therapy of Carcinoma of the Esophagus. Arnold Bernstein. Strahlentherapie, 1936, **56,** 366–376.

The author reports four cases of carcinoma of the esophagus that responded—at least temporarily—to roentgen rays. Technic: 200 kv., 6 ma., 50 cm. F.S.D., 0.5 mm. Cu + 3.0 mm. Al, 6–8 fields, 480–600 r per field. The exact localization of the area is determined by means of the fluoroscopic screen. In each instance there was a definite decrease in size of the neoplasm and an improvement of the stenosis, lasting for several months. The author recommends, therefore, the use of roentgen rays in suitable cases because further improvement of the technic may increase the efficacy of the method. Eleven roentgenograms are appended, showing the appearance of the esophagus before and after treatment.

ERNST A. POHLE, M.D., Ph.D.

GALL BLADDER, NORMAL AND PATHOLOGIC

The "Double-oral" Method for Cholecystography. Lester R. Whitaker. Am. Jour. Roentgenol. and Rad. Ther., February, 1936, **35,** 200–203.

In comparing all the methods employed in cholecystography, the "double-oral" method is recommended. This consists of one full dose of the drug following an ordinary noonday meal and another full dose following a carbohydrate supper. In a questionable result, another carbohydrate meal and another full dose may be given. The simplicity, easy excretion, conformation to physiologic principles, and degree of effectiveness are the reasons for the recommendation.

S. M. ATKINS, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Intestinal Obstruction Due to Amebiasis. Anthony Bassler. Jour. Am. Med. Assn., June 6, 1936, **106,** 1965–1968.

Endamoeba histolytica is an invading parasite living in and subsisting on the tissues, most often in the material found in and beneath the mucous membrane

of the colon. Usually the pathologic condition noted is moderate thickening of the mucosa with surface ulcerations. In practically all cases anti-amebic treatment causes a rapid reduction of the disorder. Cysts may continue in the stools, and thus the potential of recurrence of clinical symptoms is always present. No case should be considered cured without negative stools for cysts for at least six months and normal colon by x-ray examination.

A case report is presented of a male, aged 50 years, in whom *Endamoeba histolytica* was found in November, 1933. In monthly examinations after January, 1934, after a negative period of over a year, an occasional histolytica cyst was encountered. In June, 1934, treatment was resumed and in September, 1934, stool tests showed positive findings. He was not seen for a year after this and seven days after resuming treatment he was operated on for intestinal obstruction and two weeks later the feces were found to be full of amebas. Serial roentgenograms commencing three months after operation showed a marked improvement of the whole colon. The patient was still resistant to anti-amebic treatments of all kinds.

CHARLES G. SUTHERLAND, M.B. (Tor.).

Observations on Small Intestinal Physiology in the Presence of Calcified Mesenteric Lymph Nodes. Ross Golden. Am. Jour. Roentgenol. and Rad. Ther., March, 1936, **35,** 316–323.

Symptoms produced by mesenteric lymphadenitis may vary greatly. In some instances there is merely a dull discomfort in the right lower quardrant, while in others the pain is of more violent nature. The mechanism of the pain is not well understood. It may be that there is a mechanical irritation of the nerve fibers in the mesentery or that there is inflammatory irritation of the peritoneum over the node. Apparently a solidly calcified node may be just as capable of causing symptoms as one in which the disease is more active.

The author reports a series of seven patients, all of whom had calcified mesenteric lymph nodes which were probably, in all but one individual, directly related to the symptoms. Various manifestations of disturbed small bowel physiology were observed. Spasm in the loop of small intestines adjacent to the nodes was noted in four cases, and the same number showed delay in passage of the opaque mixture past the site of adenopathy. Two cases showed 9-hour ileal residue and two showed 24-hour ileal residue. Four cases showed delayed gastric emptying and one showed reversed peristalsis of the ileum. These functional disturbances may also contribute to the symptom-complex.

J. E. HABBE, M.D.

Diagnosis and Treatment of Intestinal Obstruction. Richard Goldhahn. München. med. Wchnschr., Jan. 17, 1936, **83,** 97–101.

Since the mortality is entirely dependent upon the length of time which elapses before operation, earlier diagnosis is imperative and classical signs of ileus should never be awaited, as these are late and often never present themselves. Physical signs are meager, and no great importance should be attached to constipation, as normal bowel movement may occur with obstruction. Diarrhea is reported in a certain percentage of cases of ileus. Vomiting is an important symptom, but one should not wait for the fecal type of vomitus. Hitherto much too little importance has been given to abdominal auscultation, for one so skilled can readily differentiate the loud, ringing, gurgling sounds of ileus. The early stage of peritonitis gives a similar sound, but inasmuch as both conditions are surgical emergencies, their confusion is not a serious matter. When paralytic ileus supervenes, all sounds cease.

Great stress is placed upon early roentgenographic examination, with the patient in either the erect position, or with projections obtained laterally, in order to note the presence of gas collections with fluid levels. These fluid levels appear very early, and have been observed two hours after the onset of incarcerated hernia. One can usually differentiate the large from the small intestines by the mucous membrane pattern, but when in doubt an opaque enema is indicated. Confusing conditions such as ascites with floating gas-filled intestinal coils, and gas-containing intraperitoneal abscess must be considered. It is unimportant to distinguish strangulation from obturation ileus.

It is, however, of great importance to distinguish intestinal obstruction from simulating conditions such as central pneumonia with no physical signs (in which roentgenologic examination of the chest is indicated); cardiac disease with embolic mesenteric occlusion; various colics resulting from the passage of calculi, with concomitant abdominal distention; toxic conditions, *viz.*, uremia, diabetic coma, grippe—especially when in epidemic form.

It is difficult and not important to distinguish peritonitis from ileus, and administration of morphine is condemned as masking symptoms. The treatment is essentially immediate laparotomy, except in children under one year of age, in whom it is well to wait for spontaneous resolving of intussusception or incarcerated hernia. A most complete and instructive discussion of the indications and contra-indications for the various surgical procedures is presented.

WILLIAM R. STECHER, M.D.

Intestinal Obstruction. L. R. Sante. Am. Jour. Roentgenol. and Rad. Ther., December, 1935, **34,** 744–753.

This is a review of the roentgen findings in 287 cases of the last five years, all of which were checked by either operation or autopsy findings.

The most prominent symptoms were obstinate constipation and vomiting. In complete small bowel obstruction, vomiting may be the most prominent symptom, while in large bowel, obstinate constipation and vomiting may not develop until much later. Intermittent colicky pains are a feature of acute small bowel obstruction, although later, after extreme toxemia, the pain may disappear. Gaseous distention is also present and visible peristalsis may be seen also.

The etiologic factors were post-operative adhesions as the most common; inflammatory adhesions, peritoneal veils, and constricting membranes (rare), primary and secondary malignancy, strangulated hernia, volvulus, intussusception and intestinal contents, like gallstones, and other rare conditions.

The method of examination varies with the individual case but is always begun with a flat film of the entire abdomen which, in itself, may lead to a diagnosis. If there is doubt about the loops, a barium enema is given, and if doubt still exists, two or three ounces of barium sulphate mixture is given by mouth and its course followed through the intestinal tract even though the obstruction may be complete.

Roentgen findings are the same regardless of the cause. In complete small bowel obstruction there is gaseous dilatation of the proximal intestinal loops, with development of the "herring-bone" or "ladder" pattern. Examination in the upright position or transabdominal may show fluid levels in the gas-filled pockets of the small intestine. In large bowel obstruction, gas also accumulates in the proximal loop but not so characteristically and further investigation is usually necessary. In paralytic ileus, the entire intestinal tract contains air, in contradistinction to mechanical occlusion in which no air is present distal to the point of obstruction.

The location of the obstruction is difficult, although if the dilated bowel is high it is assumed to be in the jejunum, and, if low, in the ileum. The serrated effect of the valvulæ conniventes may be seen in the jejunum. The absence of lines of cleavage and spread of the intestines may indicate accompanying fluid.

In partial obstruction, which is extremely difficult to diagnose, the barium meal is followed every hour or two, until it has completely passed through the small intestine, with the hope of seeing malformed intestine. In the large bowel every method at hand is used if necessary.

S. M. Atkins, M.D.

Polyposis of the Colon: Report of a Case. George E. W. Hardy. Jour. Am. Med. Assn., March 14. 1936, **106**, 910–913.

The author reports a case in a Cuban woman, aged 23. Roentgenoscopic and roentgenographic examination suggested polyposis and surgical investigation confirmed this finding. Autopsy revealed a diffuse polyposis of the colon to a point 40 cm. from the anus. The lower 12 cm. of the ileum was moderately and uniformly thickened.

A review of the literature suggested the simplest classification to be that of Erdmann and Morris: the adolescent and the adult type. The adolescent or congenital disseminated type manifests itself in early youth, is characterized by chronic recurring attacks of intestinal hemorrhage and diarrhea, and shows a tendency to occur in members of the same family. The adult or acquired type first appears in adult life in association with frank evidences of chronic traumatic and inflammatory lesions, to which it is evidently secondary. The two types have in common a marked predilection for the large intestine; an evidence of malignancy of more than 40 per cent, and a tendency to chronic intestinal hemorrhage and diarrhea. In the adolescent type the polyps appear in almost countless numbers, are widely disseminated, and show no gross evidence of a causative lesion. In the adult type they occur in limited numbers and extent and almost invariably are associated with gross evidence of trauma, inflammation, or foreign body. Pseudopolyposis is characterized by the formation of polyps arising from islands of mucous membrane isolated in the bases of dysenteric ulcers (Woodward).

Because of the serious danger of malignant transformation, palliative measures such as cecostomy and appendicostomy are not to be considered except in the exceptional case.

Charles G. Sutherland, M.B. (Tor.).

GENITO-URINARY TRACT (DIAGNOSIS)

Intravenous and Retrograde Urography: A Comparative Study. R. E. Cumming and G. E. Chittenden. Jour. Am. Med. Assn., Feb. 22, 1936, **106**, 602–606.

Nearly thirty years ago, the roentgen ray was made immeasurably valuable in the study of urogenital lesions by the successful practice of pyelography. The work of the cystoscopist was expanded greatly following the regular adoption of pyelographic technic. So, likewise, an added burden was placed on the roentgenologist, who was forced to learn much of the intimacies of urology in order to be of the greatest assistance possible in the interpretation of roentgenograms.

The development of intravenous urography has again increased the scope of work on the part of both the urologist and the roentgenologist. With the two methods of urography in constant and indiscriminate use, it is more than ever necessary to establish a proper alliance between roentgenologists and clinical urologists.

The authors compiled an up-to-date estimate of the value of intravenous urography from a questionnaire which was mailed to 350 active physicians. The answers to this are presented in a series of tables which comprehensively answer many of the questions current regarding various phases of the intravenous method.

Charles G. Sutherland, M.B. (Tor.).

The Radiological Findings in Pre-pyloric Lesions. A. C. Singleton. Canadian Med. Assn. Jour., April, 1936, **34**, 382–386.

The author attempts to clarify the difficult diagnosis of lesions in the prepyloric two-and-one-half centimeters of the stomach. Differentiation includes spasm from extra- and intra-gastric causes, involvement in extra-gastric disease by adhesions and extension, annular carcinoma, prepyloric ulcer, and hypertrophic pyloric stenosis of adults. Criteria for differentiation depend on demonstration of spasm, passage of peristal-

sis through the deformity, the absence of six-hour residue, palpation of a mass in the area of the involvement, and whether or not the lesion involves the prepyloric region of the stomach only.

It is interesting to note that the author regards two weeks in bed on a bland diet as being the best antispasmodic in his experience; likewise that benign prepyloric ulcers seldom produce a palpable mass in contradistinction to the malignant ulcer. Spasm is infrequently present in the pylorus in malignant ulcers.

Hypertrophic pyloric stenosis may be short, or as much as three centimeters in length. The lumen of the contracted pylorus is central, symmetrical, and involves an equal length of greater and lesser curvatures, and may indent the base of the duodenal caput. Since this lesion does not respond to antispasmodic measures, and since the age incidence is from 14 to 60 years, the condition is very difficult to differentiate from annular carcinoma. Serial examinations are of great benefit here as in other radiologic studies.

W. H. GILLENTINE, M.D.

The Bladder Function in Spinal Injury. K. H. Watkins. British Jour. Surg., April, 1936, **23,** 734–759.

The author concludes, in his study of the cases recorded, that active sacral spinal segments are of fundamental importance to bladder function. The influence of these segments below a complete transverse lesion is such as to promote a perfect reflex micturition, which differs essentially from the normal in its entire independence of voluntary control.

The behavior of the bladder in lesions of the conus and cauda equina is evidence of a limited degree of function mediated by the peripheral nerve ganglia. It has been shown above, however, that this function is not, of itself, efficient in evacuating urine from the bladder; for even when the internal sphincter is widely relaxed, and the detrusor in contraction, there may be no escape of fluid from the bladder. It can only be concluded, therefore, that its peripheral innervation alone determines a very ineffective bladder function.

It is without doubt the existence of a considerable mechanical resistance in the region of the triangular ligament which deprives this function of the bladder of most of its effect, but it is in virtue of this resistance combined with the patient's ability to expel urine by straining with his abdominal muscles, which provides him with the means of living in relative comfort. This patient is, therefore, in much better circumstances than the patient with a transverse cord lesion who, though he has a very perfect reflex micturition, is not able to control it. Several interesting graphs and roentgenograms accompany the article.

DAVIS H. PARDOLL, M.D.

The Limitations of Intravenous Urography. Thomas D. Moore. South. Med. Jour., March, 1936, **29,** 242–248.

In the author's article the following factors are cited as possibilities for poor or absent visualization:

1. Temporary or reflex inhibition of function, such as commonly occurs in the presence of a ureteral calculus;
2. Incomplete filling, rendering proper interpretation impossible;
3. Hypersecretion and hypermotility with little or no medium retained in the renal area;
4. Non-calculus obstruction at the renal outlet or along the course of the ureter; if of short duration, normal function will soon follow elimination of the obstruction;
5. Temporary impairment of function due to nephritis and occasionally to toxic states;
6. True absence of function, such as may be caused by advanced renal tuberculosis, extensive neoplasm, or pyonephrosis.

Errors in diagnosis may be explained in several ways, as follows:

1. Inexperience in the interpretation of pyelograms;
2. Unsatisfactory pyelograms for proper interpretation;
3. Reluctance to request more complete data by employing the cystoscope with or without retrograde pyelography.

In the writer's experience he has found intravenous urography to be most helpful and dependable in the following conditions:

1. In the identification of doubtful shadows in the region of the upper urinary tract;
2. In the demonstration of renal and ureteral anomalies;
3. In proving or disproving the existence of stasis;
4. In the course of differential diagnosis, the observation that both kidneys are of normal outline and function often will render a cystoscopic examination unnecessary;
5. Under circumstances in which instrumentation is inadvisable, such as acute specific urethritis, senility, patients in poor general condition, and in infants or small children.

In the presence of gross hematuria or pyuria, in the majority of cases the information afforded by intravenous urography is inadequate for the determination of the cause or source of the blood or pus. The detection of renal tuberculosis in its early stage or the exclusion of this disease in the opposite kidney requires data other than that afforded by intravenous urography. The same may be said of the diagnosis of early neoplasms, which may cause slight deformities often not discernible in the urogram. Neither can the method be relied upon for the recognition of polycystic disease with its attendant poor function.

Good visualization of the structure comprising the upper urinary tract will be greatly enhanced if due consideration is given technic. The following factors have been found of great importance:

1. The withholding of fluids for at least twelve hours prior to the examination, which induces a greater concentration of the media and, therefore, denser shadows;
2. A preliminary laxative for the elimination of intestinal markings.

3. Of most importance is localized compression immediately above the symphysis pubis by placing a small rubber ball beneath the compression binder of the Potter-Bucky diaphragm, as previously advocated by the writer.

During the actual exposure of the films, the ball should be removed in order to permit the lower ureters to fill and to eliminate the shadow of the ball. This technic has been used with much satisfaction and often affords such good visualization of the ureters that doubtful shadows in the lower third may be readily identified and such lesions as strictures, kinks, and dysfunction of the ureteral musculature may be studied, especially if serial films are obtained.

Out of a series of 150 patients the author found that intravenous urography alone sufficed for an accurate diagnosis in 97 of the cases. Of this group, the diagnosis was negative in 49. The remainder of the group of 150 cases required subsequent cystoscopy and retrograde pyelography.

An ample discussion of the author's paper is included and should be read by everyone interested in the subject of intravenous urography.

DAVIS H. PARDOLL, M.D.

GYNECOLOGY AND OBSTETRICS

Hysterography as an Aid in the Diagnosis of Abdominal Pregnancy: Report of a Case. J. P. Greenhill. Jour. Am. Med. Assn., Feb. 22, 1936, **106,** 606–608.

The author reports a case in which this method was used to confirm a clinical diagnosis of mature dead fetus outside the uterine cavity. A review of the literature revealed reports of only seven cases in which the injection of iodized oil into the uterine cavity was employed for the purpose of verifying a diagnosis of abdominal pregnancy.

Injection of iodized oil into the uterus under such circumstances is not only a simple and relatively harmless procedure, but presents absolute evidence of the presence of a pregnancy outside the uterine cavity.

When a roentgenogram shows a fetus that has a collapsed skull and/or other evidences of fetal death and there is a suspicion of extra-uterine pregnancy, or in cases in which the fetus is dead and repeated attempts to induce labor by mechanical and medicinal means fail to bring about expulsion of the child, hysterography is indicated. If the child is alive and there is some doubt as to the diagnosis, it might be dangerous to inject solutions into the uterus.

CHARLES G. SUTHERLAND, M.B. (Tor.)

Roentgen Therapy in Advanced Carcinoma of the Vagina and the Cervix. F. Baclesse. Strahlentherapie, 1936, **56,** 189–199.

The majority of radiologists advocate combined x-ray and radium therapy in carcinoma of the cervix. While the author uses the same method at the Curie Institute, in Paris, he states that encouraging results may be obtained following the use of x-ray therapy alone, chiefly if there is vaginal involvement. His analysis is based on 63 cases treated during the period 1922–1930. They were all observed for at least a five-year period. The clinical classification, technic, skin reactions, and complications are discussed in detail.

In conclusion, the author states that, although the combined roentgen and radium therapy is usually the method of choice, there are some cases which are more suitable for roentgen therapy alone. In his opinion they are those in which cancers grow into the vagina rather than into the parametrium. He obtained 14 per cent five-year cures by applying doses as high as 16,000 r. Since this may lead to late injuries, he proposes to reduce the daily doses in the future as well as to distribute the entire treatment over a period of from six to eight weeks. He also feels that an increase in the tube potential, giving better penetration, might increase the percentage of cures.

ERNST A. POHLE, M.D., Ph.D.

Discussion on Radiology in Relation to Obstetrics. Proc. Royal Soc. Med., April, 1936, **29,** 689–700.

Professor Daniel Dougal recommends radiographic pelvimetry in all primiparæ during the early months of pregnancy and stresses the value of radiography in obstetrics. The information obtainable he enumerates as follows:

1. Anatomical variations.
2. Pelvic changes due to pregnancy.
3. Size and disposition of fetus during pregnancy.
4. Ossification in fetal skeleton—fetal maturity.
5. Mechanism of labor, normal and abnormal.
6. Abnormalities (undue size, faulty attitude, malformation, malposition, malpresentation).
7. Placenta prævia.
8. Ectopic pregnancy.
9. Single or multiple pregnancies.
10. Determination of size of fetus.
11. Intra-uterine death of fetus.
12. Accurate pelvic measurements.
13. Measurements of fetal head.
14. Disproportion between head and pelvic inlet.

Dr. R. E. Roberts places before the radiologists the following as outstanding obstetrical problems:

1. Is the patient pregnant?
2. What is the position and presentation of the fetus?
3. What is its period of gestation?
4. Is there any major or minor pelvic deformity? What are the measurements of the diameters of the pelvic brim and/or outlet?
5. Is there any disproportion between the size of the fetal skull and that of the maternal pelvis?
6. Is there a multiple pregnancy or a fetal abnormality to account for hydramnios which is present?
7. Is the fetus alive or dead?
8. Is the pregnancy extra-uterine?
9. Is the antepartum hemorrhage due to placenta prævia?

He further discusses most of the problems under the following heads:

1. Period of gestation.
2. Pelvimetry and cephalometry.
3. Hydramnios.
4. Placenta prævia.

The following authors participated in the discussion:

Dr. Norman Reece stated that the biparietal diameter of the fetal head can be measured with reasonable accuracy by x-rays, and this measurement gives useful information as to fetal maturity.

Dr. Cecil Bull utilizes the sitting, recumbent, and lateral positions for measurements, measuring the diameters which appear in the three positions, and uses the tables of Scammon and Calkins to determine fetal maturity.

Dr. W. G. Mackay utilized amniography on 66 occasions in suitable cases, and in 90 per cent of them he was able to diagnose correctly the location of the placenta. This procedure has limited practical applications which are discussed by the author. In the roentgenogram, the placenta is recognized by (1) an uneven surface, and (2) thickness.

Dr. A. Durward conducted an investigation of pelvimetry and encephalometry and considers the former more important.

Dr. Rohan Williams made a strong plea for a compilation of all information with post-natal pelvimetry in all cases in which the obstetrician encountered some mechanical obstetric difficulty.

Dr. M. H. June attained some success in demonstrating the fetus in early pregnancy, 12 weeks' gestation, with the following method: patient prone, tube tilted so that the rays (postero-anterior) are perpendicular to the pelvic outlet.

HENRY K. TAYLOR, M.D.

Roentgenologic Diagnosis of Placenta Previa. W. H. Ude and J. A. Urner. Am. Jour. Obst. and Gynec., May, 1935, **29**, 667–679. (Reprinted by permission from British Med. Jour., Aug. 24, 1935, p. 33 of Epitome of Current Medical Literature.)

Thirty-five cases are reported, together with the routine technic evolved, and on which the authors lay stress. They point out that, as treatment frequently has to be by Cesarean section, there are great advantages in a method of diagnosis which avoids digital examination and shows the exact position of the placenta. Exposure must be rapid, directly anteroposterior, on a film large enough to show the whole fetus, and with a contrast material (40 c.c. of 12.5 per cent sodium iodide) to show up the bladder wall. Lateral roentgenograms are useful in determining the position of a placenta above the lower uterine segment. Normally the outline of the fetal head impinges upon that of the bladder. Placenta previa distorts this shadow, and with experience interpretation of the differences becomes possible, given a vertex presentation. Blood clot from a premature separation of the placenta needs roentgenograms at 24-hour intervals for differentiation.